Developing a Mobile Application for Local Community Awareness Based on Social Networking Data

Master's Thesis, Department of Surveying and Planning

Aalto University, School of Engineering

Espoo 08.12.2014

Saheryar Ali

Masters of Science in Computer Science.

Supervisor: Professor Kirsi-Kanerva Virrantaus
Instructor: Senior university lecturer Paula Ahonen-Rainio

Aalto University
School of Engineering

Aalto University, P.O. BOX 11000, 00076 AALTO
www.aalto.fi

Abstract of master's thesis

Author Shaheryar Ali

Title of thesis Developing a Mobile Application for Local Community Awareness Based on Social Networking Data

Degree programme Degree Programme in Geoinformatics

Major/minor Geoinformatics **Code of professorship** Maa-123

Thesis supervisor Professor Kirsi Virrantaus

Thesis advisor Paula Ahonen-Rainio

Date 08.12.2014 **Number of pages** 58+8 **Language** English

Abstract

The beginning of the 21st century has seen a technology boom that lead toward the development of social networking sites. The emergence of high speed internet, mobile devices and Web 2.0 has enabled users to add location dimension to the traditional social networking sites that has given birth to the location-based social networking sites. These sites have attracted millions of users around the world who share their location with friends and family. Currently 72% of internet users use social networking sites. This is producing an unprecedented amount of location-based social networking data.

The objective of this research was to find if location-based social networking data can help in the development of a local community awareness application which can help users to find hot topics of discussion in an area and to know what people think and say around them. This became my motivation to develop Mapo, an android based local community awareness application built on the top of microblogging location-based social networking site *Twitter*, *Google map* and *Twitter4j* an open source library for Twitter. Mapo collects the location-based tweets from an area and displays them on Google map.

After the development of Mapo, I conducted interviews among the students of Aalto university to find when and why they would use it. After interviews it was found that preferences changed from student to student and they used it to find different things i.e. what people around them think and say, events, opinion of other people about an item, street artist, restaurants and shopping malls. I have also conducted three experiments, the first two experiments were conducted by collecting location-based tweets from Peshawar and London to find if the application can help to find out the hot topics of discussion in an area. The third experiment was conducted by using the keyword search option of Mapo to find if it can help users to find items of their interests from an area.

The results of the first two experiments showed that Mapo can help users to find hot topics of discussion from an area. It can help to find what people in a local community think and say. The results of the third experiment showed Mapo can also help users to find an item of their interest from an area.

Keywords Social networks, Social networking sites, Location-based social networking sites

Acknowledgements

I would like to express my gratitude to Allah and then to all the people who supported me during my thesis work My parents, brothers Taimoor Ali, Mohsin Ali and Hassan Ali for always being there and my friends at Aalto University.

Thanks to my collegues at work specially Pasi Saarikoski, Urmas Kopra and Petri Alapiessa for understanding and supporting me in difficult times.

Thanks to Airi Lehimäki, Päivi Kauppinen and Jaakko Rantala for always being helpful pleasant personalities.

My special thanks to Professor Kirsi Virrantaus, who has supervised my thesis and provided me every possible help during my Masters studies.

Last but not the least, I would like to thank my instructor Paula Ahonen-Rainio, who had a very tough schedule but she was always there to help me, she pointed me in the right direction and helped me to define the research topic. Without her help the completion of this thesis was not be possible. Thank you!

Espoo, November 2014

Shaheryar Ali

Dedicated to my Parents for their prayers. To my maa who sacrificed a lot for our studies and to my baba for my first teacher who taught me for the first twelve years of my education.

Table of Contents

LIST OF FIGURES

ABBREVIATIONS

API	Application Programming Interface
GPS	Global Positioning System
LBS	Location Based Service
LBSN	Location-based Social Network
LBSND	Location-based Social Networking Data
MAU	Monthly Active User
OSN	Online Social Network
SMGI	Social Media Geographic Information
SMD	Social Media Data
SMS	Short Messaging Service
SND	Social Networking Data
SNS	Social network site

1 Introduction

1.1 Background

The increasing use of social media in the recent years is surprising. According to Kaplan and Haenlein (2010), social media is "a group of internet-based applications that are built on the ideological and technological foundations of Web 2.0 and that allows the creation and exchange of **user generated content** (UGC)". There are many forms of social media e.g. blogs, microblogs, social networking sites (Facebook), content communities (BookCrossing, YouTube and Flickr), virtual game world (X-Box and Sony's PlayStation) and virtual social world (Second Life).

Among different social media, social networks have got a remarkable importance in the recent years and undoubtedly helped us to understand how communities communicate and interact with each other. Location and time have an important role in social networks because of spatial and temporal context of human actions, therefore, it is important to consider them (Li and Goodchild, 2010). Location has always remained an important property of any social entity and recently many location services have been introduced, for example, **location-based services** (LBSs) have merged as a promising technology into mobile industry that has helped businesses to customize customer specific products. However, in LBSs location data was limited to the telecommunication companies.

Taking a step forward, when location dimension was added to the social networks, it has given birth to the **location-based social networks** (LBSNs). In case of LBSNs location data is freely available and can be accessed. (Bao et al., 2012). Recently many **social networking sites** (SNSs) such as Twitter and Facebook have introduced the location feature that has allowed users to broadcast their location. Microblogging and location-based SNS Twitter allows its users to share their location from a location-enabled mobile devices along each tweet to let the others know where they are and what they are doing or to interact with their followers, thus linking the social network to the real world (Gao and Liu, 2014).

Location-based social networking sites are dynamic and produce massive amount of location data. Due to this dynamic feature **social networking data** (SND) is updated continuously therefor, the temporal aspect of a social network can help to find out the recent activities of the others. The spatial and temporal properties of the social media data help us to understand the behavior of people in the physical world via virtual world with respect to location and time.

Physical proximity was such a basic concept of the social network that social scientist never paid much attention to it. "Physical proximity refers to the physical distance between two people measured in units such as inches, meters or miles" (Monge and Kirste, 1980). It was strongly believed that, social interaction was a face-to-face contact between people or among those who were living closer to each other and distance was considered a hurdle for socializing. It was believed that living closer to each other, plays an important role in building and maintaining of the social networks. However, it was just an assumption and there was no real social research behind this belief. (Takhteyev el at., 2011).

The analysts of social networks however, were the first ones to argue that a community should not be considered local (Wellman, 1979). They further suggested that, a social network has potential to extend the social relation among people across boundaries, thus creating the social networks between people who are located on different geographical locations (Takhteyev el at., 2011).

The arrival of internet was a landmark to create possibilities to maintain the social relation over longer distances. The commentators of the social networks have said that the distance has died (Cairncross, 1997). They have considered that internet would provide a faster, cheaper and content rich communication among users that would eliminate the physical proximity and would help users to maintain long distance relationships (Takhteyev el at., 2011).

Social media covers many social communities under its umbrella. Among these communities location-based social networking sites has obtained enormous popularity in the recent years making them an essential part of day-to-day life. People use them for

socializing, to share and seek information, to keep them up to date about latest news and trends and helping users to stay update about people in their social circle. The increasing popularity and the use of location-based social networking sites produces massive amount of SND. Businesses are using this data to find customers need and customizing their products accordingly while, sociologist and psychiatrist use it to study human behavior.

1.2 Research Objective and Questions

The idea of this thesis was self-driven. The main objective of this research was to develop a mobile application based on **location-based social networking data** (LBSND) that would help users to find out the behavior of people, what they say or think and what is the hot trend or topic of discussion around them. Businesses could use it to find out about customer's needs and thus helping them to customize their products accordingly. The name of this application is Mapo.

The first research question is to see whether (LBSND) can help us to find the hot trend or topic of discussion in a local community. When and where a user can use this application and if this application can help user to find the items of their interest in an area. The primary research question was divided into sub research question.

- Is it possible to developing a mobile based local community awareness application?
- What are the benefits of a mobile-based application?
- What are the limitations of such an applications?

The second research question was to see which location-based social networking site can help us to develop a local community awareness application?

The third research question was how to represent LBSND on background map? It means how to represent data (comments, messages) on their respective geographical locations on a map.

1.3 Research Methods

This research work consists of two parts i.e. theoretical and practical. The thesis started with the *theoretical* part of research to see whether the idea of *Developing a Local Community Awareness Application* can be implemented. Different technologies i.e.

Android and iOS were studied and different data sources were reviewed to see if any one of them support this idea. After initial research, it was found that **social media data** (SMD) contains wealth of information and can serve as a data source. It was also found that developing a mobile application would best suit this idea.

In the next step literature was reviewed in detail to see what social media is and how SMD can be utilized for developing a location-based application. After literature review it was clear that **social networking sites** (SNS) can serve as the primary data source. Next the *practical* part of the thesis started where the application was developed. In the practical part, the main focus was to select a technology which can help to easily develop the application. It was also well understood that application should have a simple and interactive design to be easy to use. A clear and simple information layout always leads toward a development of successful application, therefore, making a simple information layout was one of the top priority. Finally interviews and experiment were performed to find out whether the application can help to find what is happening around them.

1.4 Structure of the Work

Chapter 2 discusses social media, social networks and social media data in detail. Chapter 3 looks into location-based social networking sites and explains how social networking data with location information can be helpful in various fields, such as behavioral psychology, businesses and sociology. Chapter 4 discusses the microblogging site Twitter that has proved itself as a global town square for diffusion of information. It also explains how Twitter can help in different fields of life and especially Twitter's role as lifeline in the disaster events. Chapter 5 explains the technical side of Mapo application, including the platform selection, information flow, flowchart, design and use cases of application in detail. In Chapter 6, I have performed interviews and experiments. First experiment was performed in April 2014 while the second experiment was performed in November 2014 and then both were compared. Besides this third experiment was performed based on keyword search. Chapter 7 concludes the research and gives a brief idea of future work.

2 Data from Online Social Networks

In this chapter, we will discuss social networks in detail. No doubt, they have proven to be the most exciting advent of last decade, they do not come without pros and cons. We have become more vulnerable by sharing our personal information and location data, despite all these risks, interest in social networks increasing exceptionally. People use them to express their feeling, opinions, activities, events, for dating, professional networking, to connect to friends and family, for information sharing, for job search, for screening job applicants, helping sociologist and psychiatrist to read the behavior of people, helping businesses to market their products and to get customers feedbacks. **Online social networks** (OSNs) belong to social media and are a type of social networks. Before we discuss OSNs in detail, it is wise to explain social media and types of social media in detail.

2.1 Social Media

The beginning of the 21st century has seen a technological boom that led toward the development of high speed internet and computer technologies that in turn lead to the development of SNSs such as Myspace (2003) and Facebook (2004). This was the first time when the term "Social media"(SM) was coined. Social media is a technology platform based on the ideology of Web 2.0, that allows the creation and sharing of UGC. It has opened new ways of socializing and entertainment i.e. social interaction via short messaging service (SMS), emails, photo and video sharing sites, blogs and wikis. It has given a freedom to the common man to create, share, evaluate and discuss UGCs using personal computers, laptops, mobile phones and tablets (Hansen et al., 2009).

The concept of online social media is not new and goes back to 1979, when two students of the Duke University have developed a worldwide internet discussion system Usenet, allowing users to post messages. In 1998, Bruce and Susan Abelson developed "Open Diary" an early online SNS that has served as an online community for diary writers. At the same time, the term "Blog" came into existence, initially it was "Web log" and

changed to blog when a blogger jokingly termed it as “We Blog” (Kaplan and Haenlein, 2010). In 2011, Levinson introduced a new term for social media and named it “new new media” differentiating it from “old media” which includes TV, newspapers, magazines, and “new media” that includes email, chat rooms and websites. Compared with “old media”, “new media” was free from time and space limitations. Social media cover different virtual communities under its umbrella, it includes collaborative projects (wikis), blogs and microblogs (Twitter), content communities (video sharing sites such as YouTube and photo sharing website Flickr), social networking sites (Facebook), virtual worlds (Computer based simulated environment) (Kaplan and Haenlein, 2010; Levinson, 2011). Table 1 shows different types of social media categorically.

Table 1: Different types of social media with examples (Hansen et al., 2009)

COLLABARATIVE PROJECTS	
Wiki	Wikipedia, Lostpedia
Shared Documents	Google docs, Eitherpad
BLOGS	
Blogs	LiverJournal, Blogger, WordPress
CONTENT COMMUNITIES	
Video	You tube, Daily motion
Photo	Flickr, Picasso
SOCIAL NETWORKING SITES & MICROBLOGGING	
Socializing and dating	Facebook, MySpace, Match.com,
Professional	eHarmony
Microblogs	LinkedIn, Xing, Plaxo
	Twitter
ONLINE MARKETS	
Financial transactions	eBay, Amazone, Kiva
User generated products	Threadless, TopCoder, CodePlex
VIRTUAL WORLDS	
Computer based simulated Environments	SecondLife, Club Penguin
MOBILE BASED SERVICES	
Location sharing, Games	FourSquare, Gowalla, MapMyRun, GeoCaching
IDEA GENERATION	
Idea generation sites	IdeaScale, IdeaConnection

In contrast to the traditional social media data, Social Media Geographic Information (SMGI) contains geo-referenced data. Credit goes to the Web 2.0 technologies, which

have enabled users to share their location data with the help of location sensing mobile devices and geo-browsers thus becoming a contributor to the SMGI. These social media data are huge in volume and can be accessed with the help of the **application programming interface** (API) for research, analysis and decision-making (Goodchild, 2007). The social media data are based on facts, user's opinions and sentiments which can influence the decision-making process, analysis and design of the social media itself and other applications. Therefore, research is required to verify and set the credibility of this wealth of data (Massa and Campagna, 2014). In addition, managing the social media data is an issue therefor, to manage this innovative big data a new field Computational Social Science has emerged (Lazer et al., 2009).

2.1 Social Networks

The concept of social networks is not new and they have existed ever since humans have started to communicate and exchange things though they were existed there but not visible. A social network is a group of individuals, who share common interests and connect to each other by some means (Wasserman and Faust, 1994).

The classic definition of a social network is that, a network that is purely based on human interaction. Social networks have been studied in the field of sociology for decades; the study was performed in very careful, diligent and backbreaking methods (Aggarwal, 2011). Milgram's six degree of separation experiment is one such example. In 1967, Milgram introduced the small world problem phenomenon, where it was revealed that a person is connected to another person on average with the help of six intermediaries. He used locally forwarded postal mail service between actors to find out whether two random participants can be connected with a chain of six edges. Much research has been conducted in the traditional field of social network and many books (Carrington et al., 2005; Wasserman and Faust, 1994) have been written to provide an understanding of this perspective. However, data-centric issues have not been discussed in this work, which are common in online social networks.

In recent years, computers have helped us to maintain the social network over the internet that has lead toward the development of **online social networks** (OSNs). OSNs are one

of the most popular advent of the last decade, which have given the new way of connecting and communication. The purpose of creating a social networking site was to connect close friends and family members but due to their huge popularity and success many new SNSs were designed for a number of purposes. It has attracted people with different needs and motivated them to share their personal data voluntarily.

SNSs are one of the many virtual communities (see Table1), that allow people to connect to each other. The advancement in the technology, i.e. wide availability of high-speed internet and affordable internet enabled devices such as laptops, mobile phones and tablets lead toward the remarkable popularity of SNSs. Many exciting SNSs such as Twitter, Facebook, Google+, LinkedIn and match.com remained popular and their popularity is increasing with the time. Many content communities, such as Flickr and YouTube have got remarkable popularity too (Aggarwal, 2011). As of December 2013, alone Facebook had 1.23 billion **monthly active users** (MAUs) an increase of 16% from a year ago (Acquire Media, 2014). While as of June 2014, Twitter had about 271 MAUs to its credit (Twitter usage, 2014). These sites are immensely rich in content and contain big amount of *content* and *interconnected* data. Researchers, businesses and virtual marketing have already showed their interest in SNSs for research and analysis (Aggarwal, 2011). On one hand, these sites are flourishing a phenomenon that has become very fascinating and effective on user's communication. The social networking analysis on the other hand has proved to be an emerging field (Hakim et al., 2011).

The wide use of SNSs is inevitable nowadays and people around the world are using it for socializing, entertainment, news update, dating and opinion sharing etc. Currently 72% of the internet users use social networks. Out of the total social network users, 56% use Facebooks as their first choice followed by LinkedIn that has 14% of the users, while Twitter and Googel+ have 11% and 9% of the users respectively. This is producing an unprecedented amount of social media data. Facebook alone has more than 1.2 billion users with 829 million daily active users who spent monthly 15 hours and 33 minutes on the site (Social Media Statistic, 2014). The Twitter is producing 500 million tweets daily (Twitter usage, 2014), Instagram has 300 million photos upload, 100 hours of videos are uploaded on YouTube every minute (YouTube Viewership, 2014) and Google is processing 3.5 billion queries every day (Google Searches, 2014). All this producing

massive amount of SND which contains wealth of information. According to Gupta et al., 2013, SND has been categorized into, i.e. profile data; user generated data and derived data.

Profile data: It is required to register on a SNS (Gupta and Bhatnagar, 2013). The profile of a user can contain much vital information depending on the privacy settings of a user; a user can share his name, date of birth, sex, location, relationship status, workplace and high school etc.

User generated data: It is exclusively generated and posted by users of SNS (Gupta and Bhatnagar, 2013). Users can discuss different topics, can create events, share photos, videos, status messages etc.

Derived data: As the name suggests, it is obtained by applying different queries on SND and then using those result for specific purposes (Gupta and Bhatnagar, 2013).

The user-generated data usually referred as UGC contain valuable information. It can help businesses to find customer's needs, helping sociologist and psychiatrists to know about human behavior, helping strategist to make strategies and recommendation systems (Barbier and Liu, 2011). SND can also help to develop local community awareness applications that can give an insight of human behavior in a society and help others to find group of people among a large population who share common interests, sentiments and views on a subject. SND has played a very prominent role in emergency management, crime investigations (Chen et. al.2004), Businesses (Cross and Parker, 2004) and expert assessment (McDonald and Ackerman, 2000).

The role of SND has played an important role in natural disasters and other disastrous events. The environment around us has always made us vulnerable to unexpected events which is enough to remind us of the fact that we are not ready for emergencies, for example, the natural disasters (Hurricane Katrina 2005, Hurricane Sandy 2012, Haitian earthquake 2010, the 2004 Indian Ocean earthquake and tsunami) or other catastrophic events (Fukushima Daiichi nuclear disaster 2011). In order to monitor these situations geographical information systems and remote sensing techniques have been used but they could not be proved as promising as SND. In 2010, after the Haitian earthquake an online mapping community was formed using the open street map to speed up the rescue efforts. In emergency management social networks can help in two ways. First, instantly

gathering the valuable SND from disastrous area over the internet. Second, the connection and interactions among people over social networks can help in planning the safe evacuation of from the area, it can also help in finding the missing people and providing them shelter and other rescue efforts. Social networks produce location information known as volunteered geographic information plays an important role in emergency management (Li and Goodchild, 2012). If, the location information of affectees is known then it can speed up the relief process and can provide timely help.

2.2 Social Networking Sites and Privacy

The SNSs have proved to be the most popular cultural phenomenon in the online world (Boyd and Ellison, 2007). Despite this popularity SNSs have a very poor reputation in terms of privacy (Bonneau et al., 2009). The amount of personal information provided by SNSs have elevated privacy concerns among people. These concerns include identity theft, cyber bullying and frauds (Barbier and Liu, 2011). Social networks collect important personal information from a user and then share it to other users, for example, Facebook shares a user's name, profile and cover picture, gender and username (Facebook Policy, 2013).Twitter shares name and username of the users however, a user can share short biography, location, website and picture. Twitter also allows users to provide their mobile phone numbers to customize their accounts for the delivery of tweets as SMS messages (Twitter Privacy Policy, 2013).

2.2.1 Privacy Concerns in Social Media

Privacy in social media is becoming a serious issue and countries around the world are concerned about it. The British privacy regulators have asked Google to explain how it uses the personal information collected by the people (Tsukayama, 2013). France and Spain have openly said that Google do not satisfy their privacy criteria and after an investigation by French data protection authority CNIL, both countries have warned that if Google has not changed its privacy policies then it can face fine. Netherlands and Italy has also expressed their concerns about data protection and asked CNIL to explain if Google is violating rules in these countries (Tsukayama, 2013). Figure 1 shows the social media privacy concerns of millennials in the USA, the survey was conducted by Statista in Feb 2014 (Millennials privacy concern, 2014).

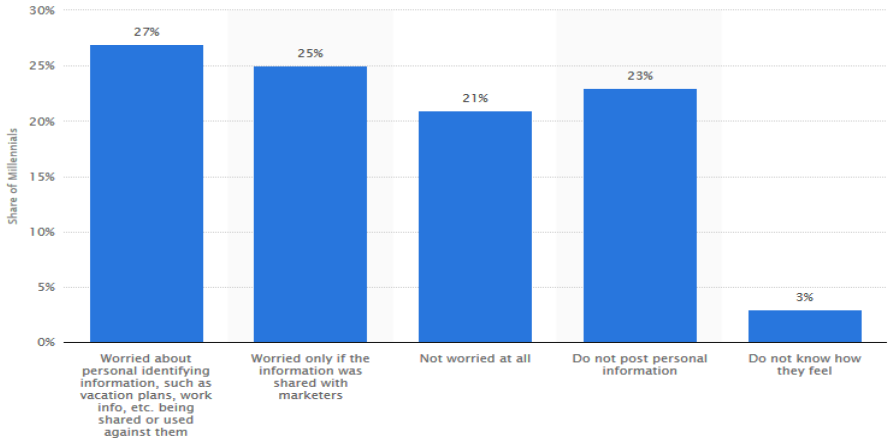

Figure 1: Social media Privacy converns of millinials in United States(Millennials privacy concern, 2014)

2.2.2 The Risks Social Media Possesses in Privacy

Social media possesses its own risks when it comes to privacy. In 2009, Harris Interactive for CareerBuilder.com reported that 45% of employers used social networks to screen job applicants, 22 percent up from a year ago. In the same study it was uncovered that 35 percent of employers decided not to offer a job to the applicants because of the information they provided on SNSs. Forty-four percent employees were not offered a job because of their drinking habit or drug use, 53 percent posted offensive and inappropriate photos and material. Other reasons included, bad-mouthed at their previous workplace, bad communications skills, discriminatory comments and lies about their qualifications (Career Builder, 2009). Insurance companies are getting information from social networks to deny benefits. For example, a woman in Canada lost her insurance benefits after insurance company found her photos from Facebook at a bar and partying during vacation (Luft, 2009).

2.3 Summary

The massive use of SNSs is producing an unprecedented amount of SND that contain wealth of information and people are using it for research and analysis purpose. SND has played an important role in natural disasters and helped to boost up the rescue efforts. However, this data contains personal information of users, which is creating security concerns among users therefore different countries in the world have taken a step forward to make sure that personal security of users is not breeched.

3 Online Location-based Social Networks

In the last decade LBSs have emerged as a promising new field in mobile and handheld communications industry. It aimed to add more value to the mobile industry and enabling telecommunications companies to provide LBSs to the users. The wide use of mobile devices and LBSs has lead toward the development of new type of social media named as LBSNs. Several LBSNs have developed since the start of the millennium. These sites allow users to leave a comment when visiting a café, restaurant or shopping mall and later people from their social network can refer to these comments when going to a place (Gao and Liu, 2014).

3.1 Information Model of Location-based Social Networks

Figure 2 shows the information model of LBSNs. It is divided into three different information layers, i.e. geographical information, social information and content information. The geographical information contains the location information and the check-in history of a user. Location can reveal important knowledge about an individual's interest and behavior in the online world; it does not only help to understand user's behavior in the online social network but also in the real world (Bao et al., 2012). LBSNs allow users to check-in the exact coordinates of their location when visiting a place and letting their friends and family know about it.

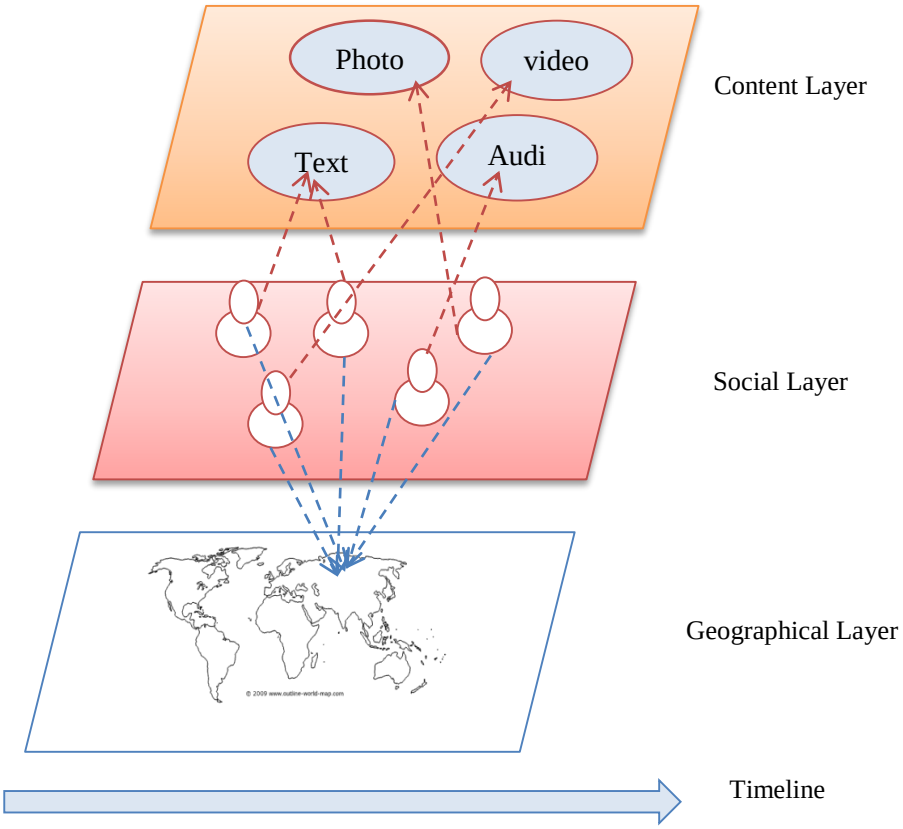

Figure 2: The information layout of location-based social networking sites (Gao and Liu, 2014)

The checking-in of location bridges the gap between the real world and the virtual world and provides an opportunity to study the user's real world behavior through the social network (Gao and Liu, 2014). Compared with the traditional geo-tagged data that have the location description of a location, LBSND have the exact latitude and longitude of a location. Facebook and Foursquare provide textual description of venues, such as the restaurants, café and movie theatre along with categories, comments and tips. Therefore, it has become possible to distinguish between two cafés on the same street or a shop located upstairs of a shopping mall. The content information contains photos, multimedia and personal views of user about a visited place. The ocial information layer contains the information about the social circle of a user. Along with these three information layers LBSNs also have a timeline that is shared by all the three layers forming a "3 +1" model. The timeline displays the timed information of user's check-ins (Gao and Liu, 2014).

In the next section we discuss different LBSNs. However, at the end of this chapter we will discuss two most famous location-based social networking sites for the application development.

3.1.1 Some Location-based Social Networking Services

Since the start of this millennium, many location-based social networking sites have developed. In the year 2000, Dennis Crowley and Alex Rainert two students of New York University launched first commercial location-based social networking service DodgeBall. It was a SMS based service that allowed users to share their location with friends who are within a radius of ten blocks with the help of short status messages. In 2005, Google bought DodgeBall and in 2009 replaced it with Google latitude (Gao and Liu, 2014).

Gowalla was launched in 2007, is a location-based service that was allowed users to *check-in* different places in their neighborhood. In 2010, feedback feature was added to Gowalla that allowed users to share feedbacks on Facebook, Twitter, Foursquare and Tumblr. Feedback feature also allowed users to leave a note for friends and family when visiting a place. By December 2010, it had 600,000 users. Figure 2, shows a user *checking-in* to place *Blue Bottle Coffee Co.* with a note *catching up with Ann* (Jon, 2010).

Figure 3 Checking in to a *place* with a note for friends and family (Jon, 2010)

In 2009, Crowley launched Foursquare, another location-based social networking site based on gaming mechanism that allowed users to compete with friends for different positions, for example, the mayor ship of a city. By December 2013, it had 45 million users and became one of the most successful locations-based social networking site in the USA (Gao and Liu, 2014). Twitter, a microblogging and location-based social networking

site that allows users to share their location information. By default, the location information of a tweet is off. However, the location information of a tweet can be turned on or off depending on user's need. When Twitter is used from an Android device it allows users to share the exact coordinates of a location.

3.1.2 Location-based Data and Application Programming Interface

Web 2.0 and **global positioning system** (GPS) enabled mobile devices have led toward the development of LBSNs (Gao and Liu, 2014). They are equally popular in all fields of life and people of different age groups use them. As of June 2014, seventy eight percent of Twitter's active users accessed Twitter via their mobile (Twitter's report, 2014). While of 2013, Foursquare had 45 million mobile users generating massive amount of social and geographical information from millions of users (Foursquare Blog, 2013). **Application programmer interface** (API) can be used to collect the data from these LBSNs for analysis and research purpose. It is worth to mention here that API is an important part of a social media that allows users to develop crawler applications to directly interact with the SND. The users can retrieve data and use it according to their need but in many cases the number of API transaction per day is limited and well depends on the affiliation between the API user and the site. As the SNSs have produce massive amount of live streaming data therefore, it may be important to limit the amount of data to be collected with crawler (Barbier and Liu., 2011).

3.1.3 Location-based Data and Recommendation Systems

The fast growth of the internet and widely available internet data have increased the number of choices., Thus, the decision-making and finding the right items have become a demanding task. In order to avoid any confusion many recommendation systems have developed in the recent years (Hosein et al., 2012), which can assist the users in decision-making. As the name suggests a recommendation system is the one that recommends different items to a user which could be of a user's interest. It includes places, such as the café, restaurants, shopping malls and items, such as movies, news, books and events (Gao and Liu, 2014). A recommendation system helps in decision-making based on the experience of other users and sometimes based on a user's own past behavior. It helps to

filter the uninteresting things and showing only the interesting ones (Prem and Vikas, 2010).

Recommendations systems are increasing becoming popular in online LBSNs that are attracting more and more users. They are allowing businesses to find new ways of business and profit and are helping in online marketing. They have emerged as a new advertising channel. Based on a user's location, distance and check-in history logs recommendation systems encourage user to visit places and buy items. (Symeonidis et al., 2014). However, we must understand the fact that the preferences change from person to person, for example, food lovers maybe looking for the restaurants, while shopping goers would be more interested in nearby shopping malls (Noulas, et al., 2011). No doubt, the opinions of the users are a valuable source of information but venue visited or recommended by a user may not be interesting for the others. SNSs Facebook and Twitter are already using recommendations for their users. For example, Facebook is helping users to find new friends based on overlapped location histories, for example, people visiting the same restaurant or shopping malls can be sent friendship recommendation based on the same interests. In Figure 4, friendship recommendations have been sent to the user based on mutual friends.

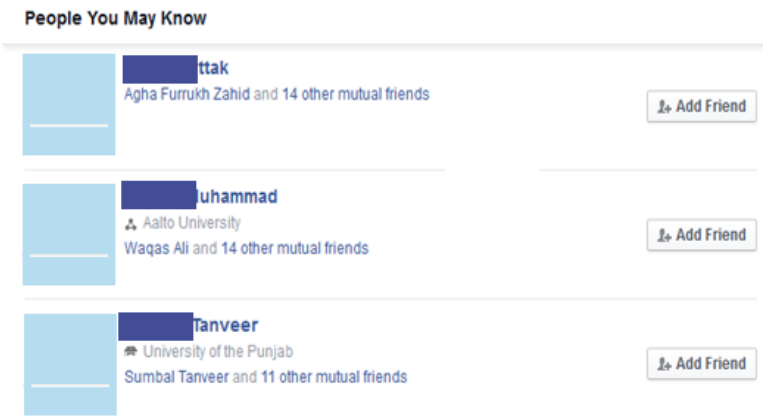

Figure 4 A friend recommendation system. (Facebook)

3.2 Location Prediction and Privacy

Location prediction has been long studied and is a primary task in mobile computing. Many researches have been conducted on location prediction to improve the location prediction services (Gao and Liu, 2014), such as the traffic forecasting (Dia, 2001), disaster management (Wang and Huang, 2010) and mobile marketing (Barnes and

Scornavacca, 2004). Currently, location prediction focuses on two areas, predicting a user's home location and location of a user himself at any time. It would help to understand the user's psyche and thus helping businesses to customize their products and outline news for nearby users (Gao and Liu, 2014).

Social network information can help to predict a user's home location from the home addresses of his friends (Backstrom et al., 2010). For example, in Figure 4 city of user was predicted on the basis of information provided by the user's friends. User's three friends come from Helsinki, Finland. While, forty three friends come from Peshawar, Pakistan. When user was asked about it, he answered that currently he is living in Helsinki while his native town is Peshawar, Pakistan.

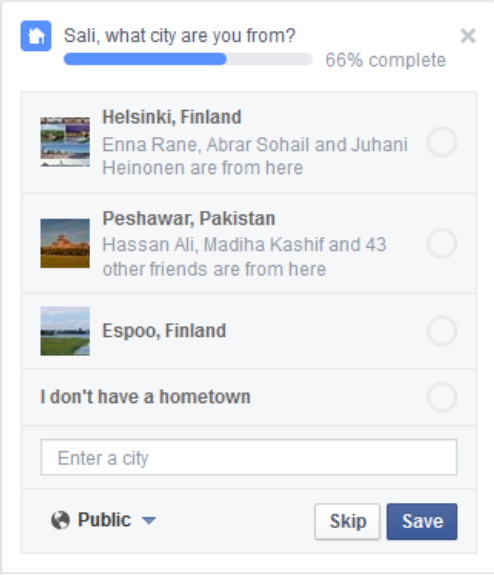

Figure 5 Facebook provides location prediction facility (Facebook)

Home location of a user remains static while, current location keeps changing. Finding the current location of a user is still under study.

3.2.1 Location Privacy

Location is an important property of LBSNs that allows users to let others know where they are and when. However, location sharing has remained a sensitive topic. When using location sharing services different users behave differently. Some users would like to share their location for socializing while, others would take it as a risk to their privacy and security. Sharing of location may help our friends or family to know where we are

and if they want to meet or hang out with us after knowing that we are nearby. At the same time the advancement in location technology making us more vulnerable to the security threats by allowing others to locate us or keep track of our movement. Therefore, it is important to seriously consider privacy control when designing location-based social services (Consolvo, et al., 2005; Gundecha, et al., 2011).

3.2.2 Research on Location Privacy

In order to improve the design of location sharing services, researchers are working to find out when and why people want to use location sharing services and when they do not. Many surveys have been conducted in this regard, for example, users use Foursquare for fun and socializing, discovering new places, keeping the track of places they have visited and competing with each other to get the badges. It is also found that a user may not check in at a place due to the privacy concerns because either the place is too sensitive or embarrassing (Lindqvist et al., 2011). In 2007, Humphreys conducted a survey on Dodgeball and found that location sharing can influence our urban and social life. For example, sometime after knowing that a friend is nearby a user may want to meet up but may ignore when he is busy. Location privacy is a very personal thing therefore it should be taken into account when designing a LBS. A user must be all free to decide if he wants to share his location or not.

3.3 Comparison of Facebook and Twitter

Currently Facebook and Twitter are two most famous SNSs with Facebook capturing 56 percent of internet users while, 14 percent of the users use Twitter. This is producing an unprecedented amount of social media data (Social Media Statistic, 2014). The importance of SNSs depends on two things, our needs and what we actually value the most i.e. information or connection. When it comes to *information* Twitter is better than any other social networking site while, Facebook is famous for *connecting*. Twitter is about *ideas and information* whereas Facebook plays a vital role in *socializing* and lets users to *connect* to friends and family. Connection and information both play an important role in a user's life and one gets importance over another depending on the user's needs and social preference (Steve, 2014). According to Diffen, "Facebook is for connecting

with the people you went to school with and Twitter is for people you wished you had gone to school with" (Diffen, 2014). In the following session, we discuss some battle grounds and decide which could be best for our application.

3.3.1 Real Time News Attention

The use of Twitter has increased incredibly in the recent years. Compared with the traditional news services such as BBC, CNN or Fox news people around the world are using Twitter as a source of breaking news. In 2011, during the Arab spring in the Middle East and during occupy of the Wall Street movement; Twitter was used for organized protests and to share location. Facebook lets users to find out what friends or their friends are saying about a big event such as football world cup final but with Twitter they can find out the whole world saying about an event. Twitter wins the battle of real time news attention also, the short length status message of 140 characters forces user to be very concise (Steve, 2014).

3.3.2 Mobile Attention

Twitter's 140 characters status messages and SMS roots makes it best suitable for mobile phones. The main reason of 140 character length was its reliance on mobile messaging. As, the limit for a SMS is 160 characters therefore, the maximum length for a tweet fixed to 140 characters while leaving 20 characters for username, letting users to receive a tweet in one single message. Twitter allows users to add location coordinates along with every tweet letting others know what they are doing. Twitter is more famous among mobile user and its 81% of advertisement revenue is generated from mobile advertisements. However, Facebook's mobile application has faced some delay to come to the market therefore, it could not get much mobile attention. In addition, Facebook struggled to bring all the complex feature to the mobile app. Twitter once again wins the battle (Steve, 2014).

Twitter played an important role in natural disasters and the events detection and its role in disastrous events appreciated as a lifeline. Twitter also played its role in politics and media events. It is playing its role as a global town square where people come to share and seek information. It is the quickest source of diffusion of information. So overall

Twitter was the best choice over Facebook which is mostly used for connecting and socializing.

3.4 Summary

In contrast to the SNSs which enabled users to connect to their friends and family, location-based social networking sites allowed users to share their location with friends and family and letting them know where they are. They have bridged the gap between physical world and virtual world and helped to understand the behavior of users in real world via Virtual world. The location-based social networking data contains valuable information and helping in different field of life. However, privacy issues must be addressed when designing LBSNs.

4 Twitter a Microblogging Location-based Social Networking Site

Microblogging is a new flourishing phenomenon that allows users to publish real time short status messages usually less than 200 characters via mobile phones, web services, email and instant messages. It allows users to discuss different topics, issues and everyday events and express their opinion and sentiments about different products, this can be done with many blogging services, such as Wordpress. Compared with the traditional blogging where a user updates once in several days, microblogging allows users to share several posts in a day. Also, microblogging is a faster way of communication. It provides users, an easy way to communicate in day-to-day activities (Java et al., 2007).

4.1 Why and How People Use Microblogging Sites

Why and how people use microblogging sites is an abstract question and varies from user to user. In order to answer this question Java el at. (2007), evaluated a user's intentions for using microblogging sites and related intentions directly to a user's desire of searching something on these sites. According to Jansen 2007, a search query could be for one of the three reasons, i.e. informational, navigational and transactional purposes. People blog for many reasons and it consists of a person's personal sentiment and point of view. Blog's topic may vary from life experiences, politics, sports adventure, opinions and emotions. Sometime blogs are for a particular audience making social groups in the real world and sometime bloggers find it hard to blog anything (Nardi et al., 2004). A user's interest at a blogging forum could be found by the people in his relationship and the response he gets from others in the form of comments. Similar to blogs, microblogging typically shows a person's personal interest, emotions and mood which vary from time to time.

Java el at. (2007), selected Twitter to find out a user's intentions to use microblogging sites, they found that people use twitter to share information, to get news updates,

reporting news and follow their favorite celebrities, topics and brands etc. In the coming section, Twitter is explained in much detail.

4.2 Twitter

Twitter is an online location-based social networking site as well one of the most popular microblogging platforms (Pontin, 2007) that was incorporated on 19 April 2007 and supports more than thirty five languages. It has 3300 employee worldwide out of which fifty percent are engineers. It has been growing at a very fast pace since its birth as of June 2014, Twitter had 271 MAUs (Twitter usage, 2014) up from approximately 125 million in 2009. It is very popular among politicians, celebrities, sportsmen and students. It has also caught the attention of the different people and communities who are interested in analyzing its content (Barbosa and Feng, 2010). It allows users to post short status messages up to a length of 140 characters known as *tweets*. Usually tweets could be seen by anyone unless one wants to keep them private. A user uses *follow* option of the twitter to get tweets from other users but tweets of a user can be accessed directly too (Takhteyev el at., 2011). Once a user is followed his recent tweets can be seen.

If, Twitter is used from a location-enabled mobile device then it allows users to share their geographic location during the process of tweeting. Users can share their geographic location either manually by mentioning it in the location text field of their profile which accepts characters up to a length of 30 characters or by sharing the exact coordinates with GPS enabled mobile devices. However, sometime the profile location is not reliable for analysis purpose because a user can mention anything in the location field and Twitter does not provide any automatic verification of location. For example, a friend of mine with profile location set as *Espoo* was tweeting from Paris with tweet location still as Espoo, thus creating noisy data. Therefore, for analysis purpose tweets with exact coordinates are reliable. Figure 6 shows different tweets; first tweet has no location information while, the next two tweets have location information. It can further be noticed that the tweets tweeted from two different municipalities of Finland i.e. Espoo and Helsinki.

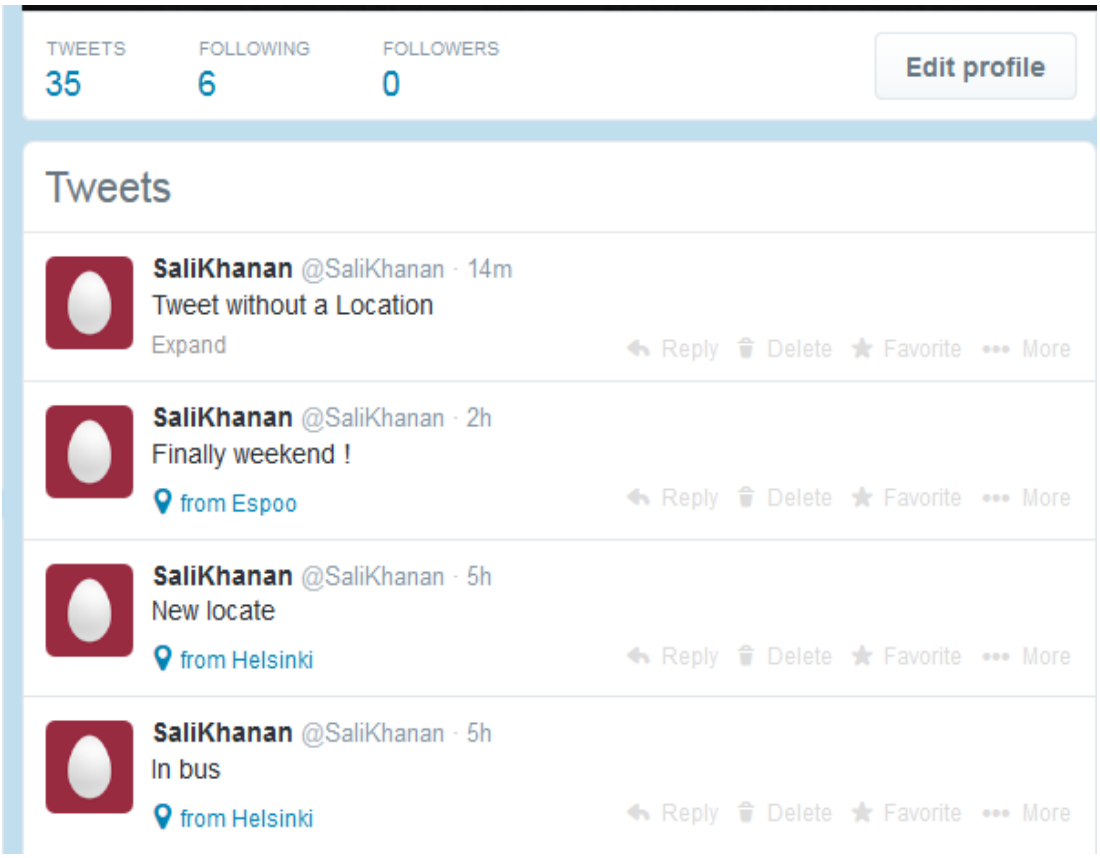

Figure 6: Tweets with and without Location information (Source Author)

A tweet is compose of some particular features, which are illustrated in the Figure 7.

RT @twUser: Obama is the first U.S. president not to have seen a new state added in his lifetime. http://bit.ly/9K4n9p #obama

Figure 7: Example of a tweet (Barbosa and Feng, 2010).

Where RT is an abbreviation of the retweet, a retweet is a forwarded tweet from a previous post. *@twUser* represents that tweet is a reply to the user *tsUser*; this way user is automatically informed of the reply. *#obama* is a hash tag provided by user to increase the visibility of this post. Where *http://bit.ly/9K4n9p* is a link to some external source (Barbosa and Feng, 2010). Along with these features, a tweet possesses some characteristics too which are as below.

Length: Maximum length of a twitter message is 140 characters.

Domain of tweets: Compare with blogs, wikis and other online forums which focus on a specific topic, tweets cover a large variety of topics.

Location: Tweets coming from location-enabled mobile phones include location coordinates (Go et al., 2009).

Emotions: Many tweets contain emotions and people are using them to express their real life emotion than to say them aloud. Figure 8 shows, what people say about emotions. One retweet says that "I find it easier to tweet emotions than to say them out loud", while another retweet says "People don't tweet thoughts like they used to.....they tweet emotions" (Tweet Emotions, 2012).

Figure 8: An example of people's point of view about emotions (Tweet Emotions, 2012).

However, sometime an emotion does not explain the true sentiment of a tweet, for example, the tweet in Figure 9, "@SaliKhanan: :(I Love Pizza….", if the tweet had no sad emotion then most people would consider it as a positive or neutral tweet.

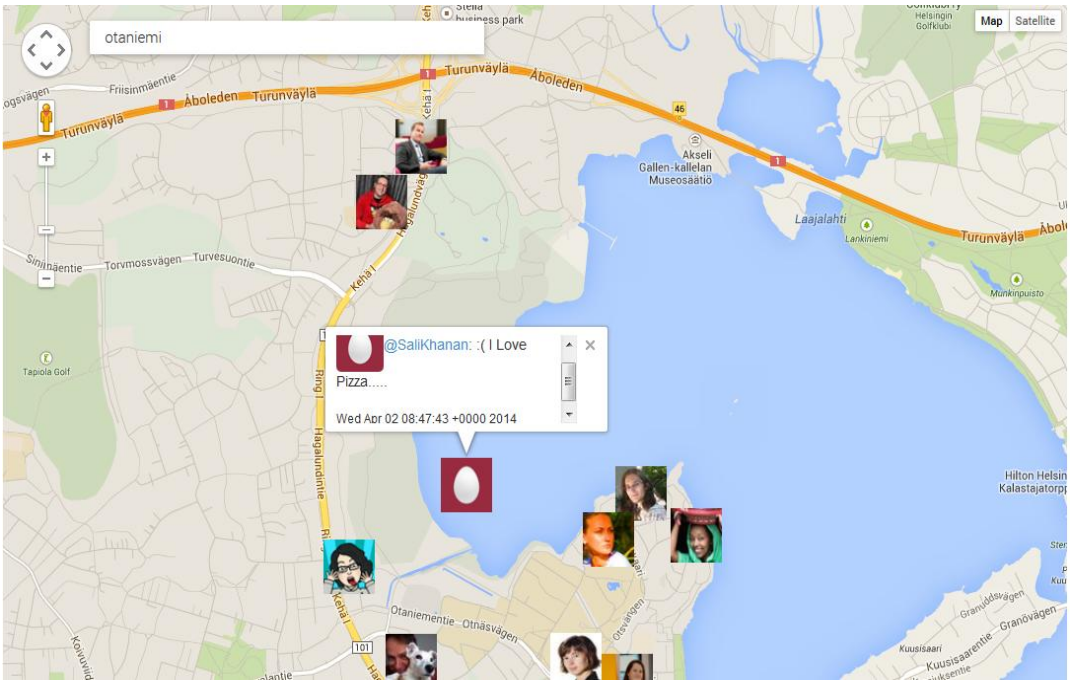

Figure 9: positive or neutral tweet with sad emotion (Source Author)

4.2.1 Types of Tweets

On microblogging site Twitter, posts can be classified as subjective and objective (Barbosa and Feng, 2010). Objective posts are fact based while, the subjective are based on personal opinion, sentiments and emotions about entities and events which, can be positive, negative or neutral (Liu, 2010).

Subjective tweets are the one which are based on opinions. In the recent years, opinion gathering has become an important part of opinion trends, search engines and ratings. Opinion enhances the search experience of users by explaining the intuition of a subject. Two decades ago, when the first time World Wide Web came into light, the way information was collected, managed and interacted with has completely changed today. With the advent of new online mediums, i.e. blogs, microblogs, wikis, forums and SNSs it has become very easy to collect the information of our need and interest. Technology has enabled us to share our opinions, ideas and knowledge with others instantly. It has lead toward a new area of research that has enabled people to search for opinions at any time about any item, i.e. places, products, movies, events and people. (Padmapriya and Maheswaran, 2012).

In contrast to subjective tweets, **objective tweets** are fact based and fact gathering has always remained a fugitive process. In an organization, the right level of trust and fair participation of staff is an important part of fact gathering. However, if the participants know that the real purpose of fact gathering is to reduce the number of staff or to bring some other changes to working environment, then it is closer to impossible to expect them to tell truth. The solution to the problem is trust and loyalty between employer and employee (Graham, 2008).

When it comes to social networking and microblogging sites, such as Twitter, people post all kinds of messages that includes personal opinion, sentiments, news, events and facts. Hence, it is difficult to differentiate between facts and opinions unless we know the source of the information. If, the information is coming from a trusted source then we can accept it. Tweet in Figure 10 is taken from Barack Obama's Twitter account, as it is coming from a trusted source therefore, it can be trusted.

Barack Obama @BarackObama Mar 22
Make sure you're covered in 2014. Check out your options today:
http://ofa.bo/sMX #LastCall2014 pic.twitter.com/q465ErgBTd

Figure 10: A fact based tweet. Source: @BarackObama

However, we must understand the fact that technology comes with pros and cons. Sometime, a fake tweet coming from a trusted source can cause irreversible damage as it happened on 23rd April 2013, a tweet from the Associated Press cried out "Breaking: Two Explosions in the White House and Barack Obama is injured". Within 3 minutes the S&P alone wiped out about $136.5 billion while, it cost nearly $200 billion to the broader market (Russia Today, 2013). Soon the Associated Press came into action and explained that their twitter account was hacked and that the tweet was fake. (USA Today, 2013).

4.2.2 Advantage of Twitter over Other Information Channels

According to Li et al., 2012, Twitter has three advantages over news portals, blogs and other information sources. First, it has 78 percent mobile users that allows a user to tweet instantly and one does not have to be a news reporter to report news over Twitter. Tweets are created in real time if, there is a shooting or a bomb blast at some public place it would be instantly tweeted by someone after the event has actually happened however, it may

take hours to be reported on other news sources. Secondly, Twitter has millions of active users who constantly tweet about events that happen around them thus covering almost every aspect of life, i.e. eating at a restaurant, some party in the neighborhood, an accident in the town or some natural disasters. Third, Twitter allows user to share the exact coordinates along each tweet thus, it provides geo-references data. All this makes Twitter an ideal application for event detection and analyzing.

4.2.3 Growth of Twitter

Twitter was launched in 2006 and since after winning South by SouthWest (SXSW) conference Web Awards in March 2007, its popularity has increased every day (Java el at., 2007). According to eMarketer's prediction Twitter's monthly active users were expected to reach the landmark of 227.5 million in 2014 and rising to about 387 million by 2018, see Figure 11. There is a constant rise of about 40 million users each year until the end of 2018. Chart was created with the help of https://datawrapper.de and data was obtained from eMarketer (eMarketer data, 2014).

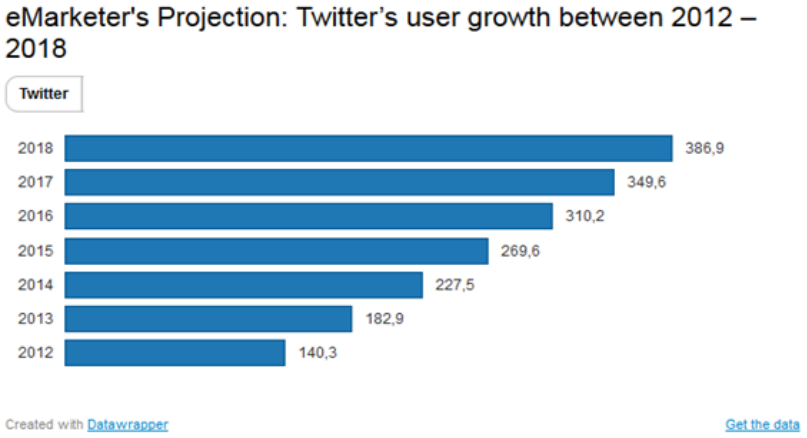

Figure 11: eMarketer's prediction, Twitter's user growth 2012 – 2018 (Twitter's global user, 2014)

However, Twitter has announced that as of 2nd quarter of 2014, the microblogging site had 271 million monthly active users a jump of 53 million users from 2nd quarter of 2013 (Twitter usage, 2014). Figure 12 shows that there has been an 18 percent growth in Twitter's MAUs from December 2012 to June 2013, an addition of 33 million users while, a rise of about 24.4 percent users from June 2013 to June 2014.

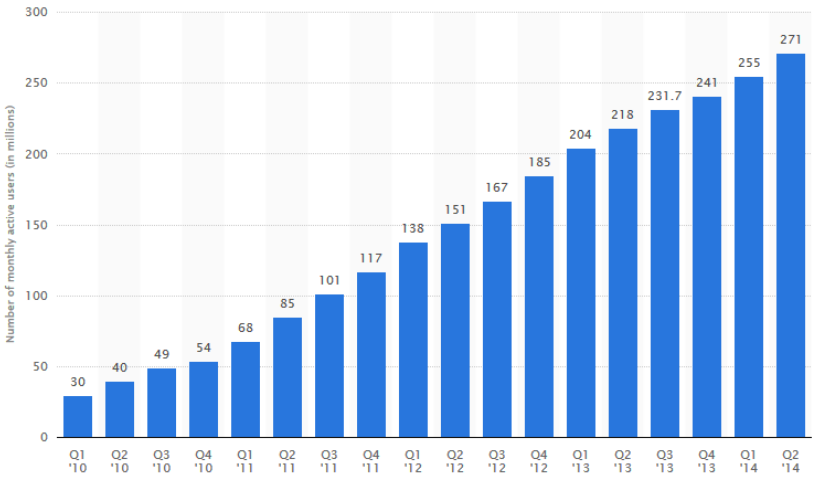

Figure 12: Growth of Twitter's monthly active users, between 1st quarters 2010 to 2nd quarter 2014. (MAUs, 2014)

4.3 Event Detection in Twitter

An event is a concept, which gains popularity either locally or globally. It can be shooting crime at a public place, a natural catastrophe i.e. earthquake, hurricane or fire, a political event i.e. elections or political unrest or a media event i.e. football world cup 2014 or 2014 super Bowl (Chua and Asur, 2013). Social networks have made it possible to diffuse information instantly and Twitter is playing an important role in it. Using Twitter's streaming API it is possible to access the incoming tweets. These tweets contain spatio-temporal aspect; therefore, it is possible to find out what has happened where and when.

Twitter has played a very vital role in **disaster events**. For example, its role in Typhoon Haiyan 2013, where it has helped the missing people to get back to their near and dear ones. In Thai flood (Kongthon et al., 2012), it has helped affectees to diffuse and obtain up to the minute information. In the event of the great east Japanese earthquake (Miyabe et al., 2012), it has helped people to directly communicate with each other via retweet and in hurricane Sandy (Guskin and HitlinPew, 2012), for its services it was declared as a lifeline. According to Gao et al., 2011, Twitter has helped authorities to find out what kind of help and resources are needed in disastrous areas.

Twitter is playing an important role in **political events**, every single tweet is a voice from a constituency that can either support or oppose a candidate. Twitter is helping politicians to run and boost their election campaign. It was famously announced before the event of

US presidential election 2012, that it is not an election of bloggers and political gurus but tweeters. Time has proved that, it is not an era of the blogs any more but this is time for Twitter (Mills, 2012). Twitter has played an important role to bring the insides of politician to us, for example, the scandal of the former New York congressional representative Anthony Weiner, who later had to resign from his post (Fahrenthold and Kane, 2011) and the scandal of Steve Cohen (Helderman, 2013).

The role of twitter in **media events** was witnessed by football world cup 2014, where in the final match 32.1 tweets were tweeted while, 35.6 million tweets posted in semifinal match between Germany and Brazil (Mogg, 2014). Other media events such as award ceremonies i.e. Oscar, news and TV shows all equally get coverage on Twitter.

4.4 Summary

Twitter has enabled users to share their opinion and sentiments more often as compared to blogs and other online forums. The role of Twitter has already been acknowledge as a life line and has got the status of global town square, where people come to share and seek information. Thus LBSND of twitter can help to get aware of local communities.

5 Mapo a Location-Based Mobile Application

Mapo is a mobile application based on LBSNDf. The primary data source is Twitter. The application helps users to find interesting trends and topics in an area based on the other user's tweets. The application collects data from twitter and displays them on geographical layer. Google map is used as a geographical layer.

5.1 Selection of Platform

The selection of right platform is always a challenging task and plays an important role in the development of an application. When developing Mapo, I had Google's Android and Apple's iOS as my first choice. Certain factors were considered during the selection of platform i.e. ease of use and access, availability and diversity which are discussed in the coming section.

The technology boom has changed the world as it was 10 years ago. Due to the availability of high speed internet and smartphones, people have switched from the personal computers and laptops to the smartphones and tablets. Considering the popularity of mobile devices, many mobile applications have developed in the recent years. Smartphones has given users the *ease of use and access* an application whenever and wherever they want. The popularity of smartphones can be considered from the fact that many websites have already introduced mobile application i.e. Twitter and Facebook. Twitter has 78% monthly active mobile users and its 81% of advertisement revenue comes from mobile advertisement. The other mobile applications such as WhatsApp and Viber are also quite famous among mobile users. The *ease of use and access* lead toward the development of a mobile application. However, the next step was the selection of best suitable mobile platform. I had Android and iOS as my option for the development of mapo. In the following section we discuss different mobile platforms to select the one which best.

Android is a Linux based open source operating system for mobile devices owned by google and developed with the contribution of the Linux open community. Currently android is the most popular mobile operating system and every day more than 1 million users powering up a new Android device. The popularity of android can be considered from the fact that, every month people download more than 1.5 billion mobile games and applications from Google Play (Developers, 2014).

Android applications are developed in java language. The Android Development Tools bundle can be downloaded from Android website to start the android application development. It contains Android Software Development Kit (SDK) and Eclipse Integrated Development Environment (IDE). Application development, testing and debugging all can be performed with the SDK (SDK, 2014).

Compared with Android which is owned by Google, the iOS is an operating system developed by Apple for its mobile devices such as iPhone, iPad and iPod touch. Apple's iOS is a closed platform and therefore an application developed for Apple's devices does not work on other devices. For the development of Apple's applications one requires knowledge of Objective-C and use of Apple SDK.

Considering the following facts, android platform was chosen for the development of Mapo.

- Android is an open source, therefore it can be installed on game consoles, wearable devices, cars and mobiles devices. Android application can be installed on different mobile devices such as HTC, Samsung, LG and Sony. While iOS is closed platform, applications developed with iOS would only be install on Apple's hardware, keeping those applications only restricted to Apple's devices (Edwards, 2014).
- As of Aug 2014, Apple's iOS market share is only 11.7% while android's market share is 84.7% (Edwards, 2014).
- In the second quarter of 2014 iphone sold 35.2 million mobile devices while 255.3 andoird phones were sold. In other word for every single iPhone seven android phones were sold.

- Many mobile companies such as Samsung, HTC, LG, Sony, One Plus One, Google Nexus, Huawei, Pantech, ZTE, Acer, Asus, Amazon use Android OS making it one of the most famous development platform in mobile industry.

5.2 Information layout of Mapo

There are three main components of Mapo i.e. tweets, Google maps and Mapo Algorithm. Figure 13 shows the information layout of Mapo.

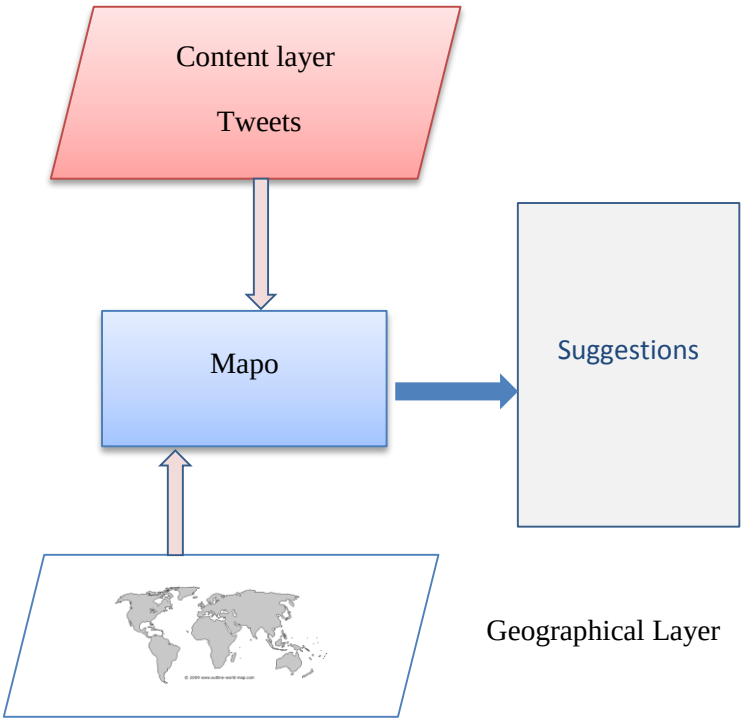

Figure 13: Information layout of Mapo (Source Author)

The content layer contains the information shared by users in the form of tweets, only those tweets are collected that have location coordinates attached to them. Mapo collects the tweets and their coordinates from content layer and passes it to the geographical layer. The geographical layer displays tweets in the exact geographical location. Figure 14 explains it more clearly.

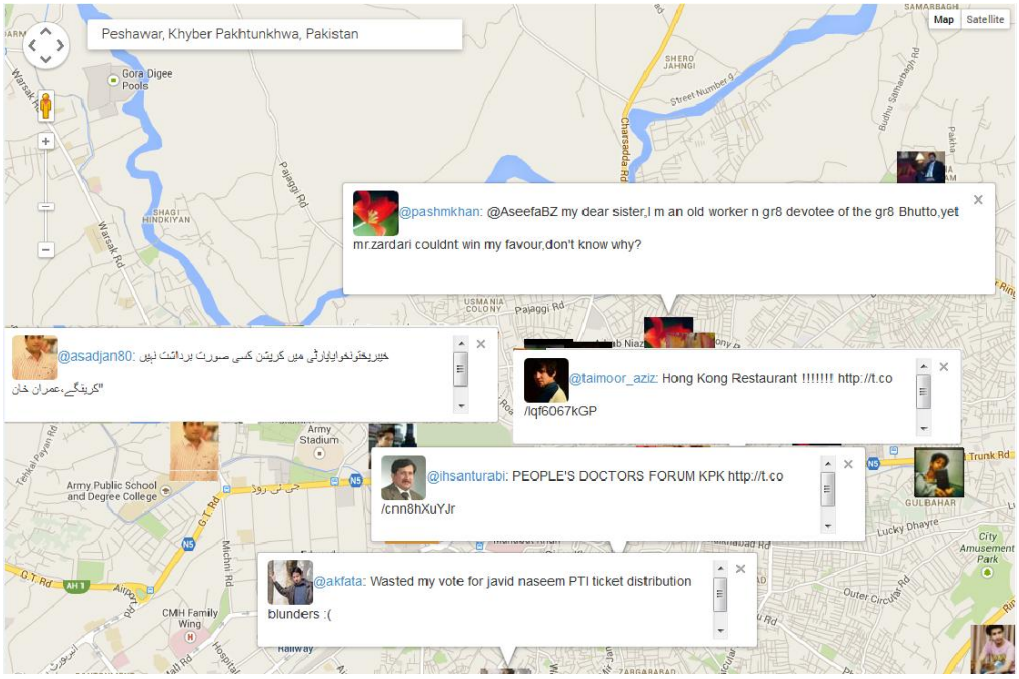

Figure 14: Army Stadium Peshawar (Source Author)

Here, Google map serve as geographical layer, while data is collected from content layer. Twitter provides SND of user along with exact location to display it on Google map. Profile picture of user serves as location mark. When a user clicks on the profile picture, it displays the tweet.

5.3 Flow Chart of Mapo

A flow chart is a diagram that explains the workflow of an application or activity in a detail sequence. Figure 15 represents the workflow of Mapo. The first step was to register the Mapo application with the Twitter, after the application was registered Twitter has generated API keys i.e. consumer key and access token for the application. Twitter's data cannot be accessed until and unless an application is not authorized with the generated API keys. Once application has registered and API keys are authorized request can be made to Twitter API to access data (Twitter Authorization, 2014). I have used Twitter's library **Twitter4j** to access tweets from streaming API, as I was interested only in location-based data, therefore, I have only parsed tweets with location coordinates. Mapo, collects tweets long with location coordinates and stores them into a *list*. Finally, Google map is rendered and tweets are displayed on the map.

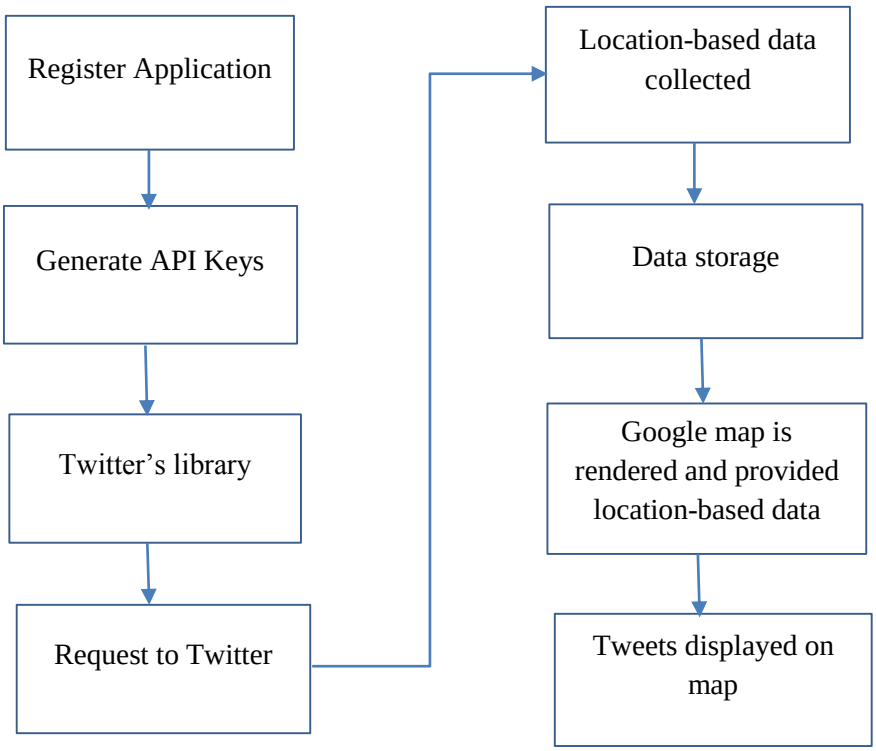

Figure 15: Flow chart of Mapo (Source Author)

5.4 Design

There is a popular belief that the design is about look and feel of a product and designer's job ends when it is handed over to the development team, but in reality design also plays an important role in interaction between product and its user. According to the Apple's founder, Steve jobs, "Design is a funny word. Some people think design means how it looks. But of course, if you dig deeper, it's really how it works." Sometimes an application has a very good design but the users find it very hard to use it. On the other hand, sometimes application is very useful but has an awful design. Therefore, when developing an application, balance should be maintained between design and usefulness. Designing an application for the smartphones is challenging as compared to that, which is developed for desktop. Because screen is small, therefore an application developed for a smartphone should best fit the screen. On a smartphone, a user can be kept more focused an engaged when the application is on the full screen, it helps to keep the distraction away and user can get the best experience images, videos, games and maps. Newer versions of Android

support lean back and Immersive mode for full screen (Android Design, 2014). Figure 16 displays lean back and immersive mode of Mapo.

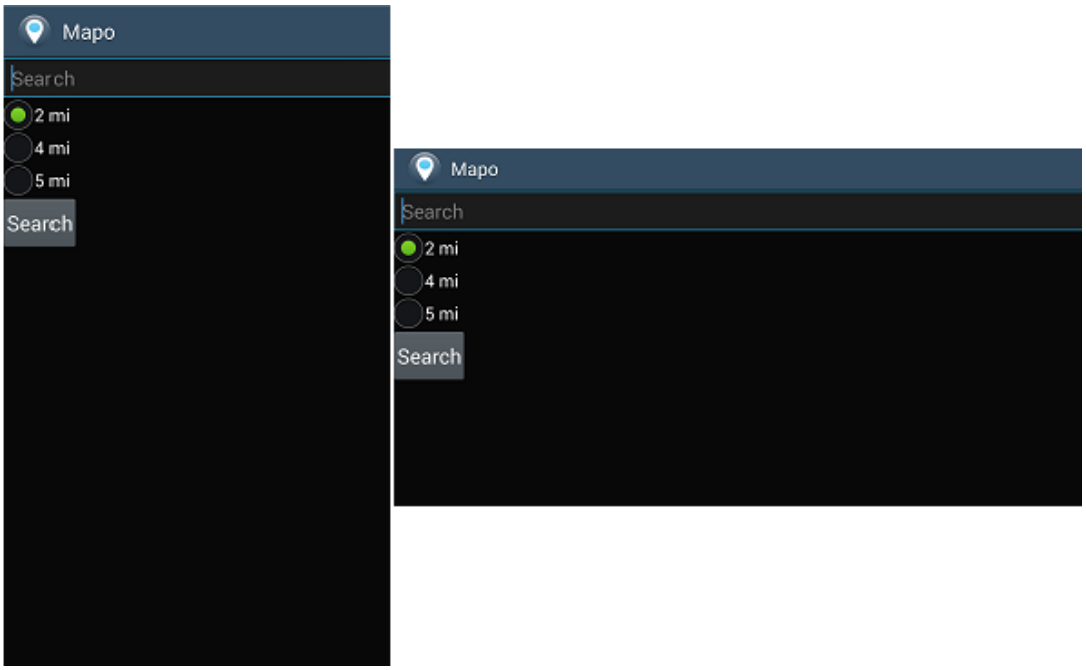

Figure 16: Lean back and immersive approach for Samsung S4 (Source Author)

5.5 User Interface

Figure 16 shows the user interface of Mapo is simple, interactive and user friendly. The main feature of application is to search on the basis of keywords, it also allows users to search from current location within a 2, 4 and 5 mile radius. When a user clicks *Search* button, Mapo searches all the tweets based of search criteria within specified radius and display it on map. It also allows user to search without any keyword, in that case Mapo searches all the tweets with in specified area. The maximum numbers of tweets that can be displayed on the map are 50.

5.6 Use Cases

Mapo is a simple to use application that has two use cases. Both use cases are based on location, however in one use case tweets can be searched without any search criteria.

User Case 1: Search Tweets on the Basis of Search Criteria

Actor: Anyone

Device: Any Android device

Precondition: Mobile device should have an access to the internet and GPS must be enabled, install the application.

1. User opens the application and the main screen appears as shown in Figure 16.
2. User enters search criteria.
3. By default, area of search is set to 2-mile radius, however a user can change the area of search to 4 and 5 mile.
4. Click *Search* button.
5. Map is displayed and is zoomed to the current location of the user. Mapo gets the current location from the GPS of the mobile device. Profile pictures of Twitter's users account appear on the map. Only those tweets are displayed that satisfy the search criteria.
6. The map can be panned and zoomed with fingers.

User Case 2: Search Tweets without Search Criteria

Actor: Anyone

Device: Any Android device

Precondition: Mobile device should have an access to the internet and GPS must be enabled, install the application.

1. User opens the application and the main screen appears as shown in Figure 16.
2. User can leave the *Search* text field empty.
3. User can select the area of search i.e. 2, 4 and 5 mile.
4. Click *Search* button.
5. Map opens and is zoomed to the current location of the user. Mapo gets the current location from the GPS of the mobile device. As, no search criteria is given therefore, all the tweets are displayed this time.
6. The map can be panned and zoomed with fingers.

5.7 Summary

Mapo was designed and implemented based on the use cases discussed above. Android platform has been used to develop the application, the user interface has been kept simple and easy to use. It has two use cases and both of them work as expected.

6 Mapo Application Interviews, Experiments and Results

The motivation for developing Mapo was to develop an application that can serve as a *local community awareness application*, that is, an application that can help users to know what people say or think around them or to find out the hot topics of discussion when they travel to a new place. Also helping users to find items of their interests with keyword search.

6.1 Interviews

After developing the application, I introduced it among the students of *Aalto university school of science and technology* and conducted interviews. Before every interview, I have let students to play with Mapo for thirty minutes and asked them to search for the things with keywords and without keywords. The first impression I got from the students was that some were already looking for this kind of application. There were two main questions which were asked from students during the interviews.

- When a user would use Mapo?
- Why a user would use Mapo?

6.1.1 Interview 1

Interviewee: Davin from Germany, an exchange student at Aalto University.

When would use you Mapo?

He replied that "I may use it when moving to a new town, I would use the keyword search option of the Mapo to find out the people who are interested in the same sports i.e. ice hockey or football and if people in the neighborhood have tweeted about it then I may contact them via Twitter to see if they are interested in playing ice hockey. If they are interested then we can decide a time can play it". From this, I have concluded that, it can help to find a group of people in a local community who share the same interests.

Why would you use Mapo?

To my question, he replied. “I may use it to find the opinion of local community about something or item”. As Mapo relies on Twitter’s data therefore, sometime a user may not find a single tweet when searching for a keywords. Actually when Davin was using Mapo he searched for several keywords i.e. date, cold, morning and football. He has found tweets for date, cold and morning see Figure 17, but didn’t find any tweet for football.

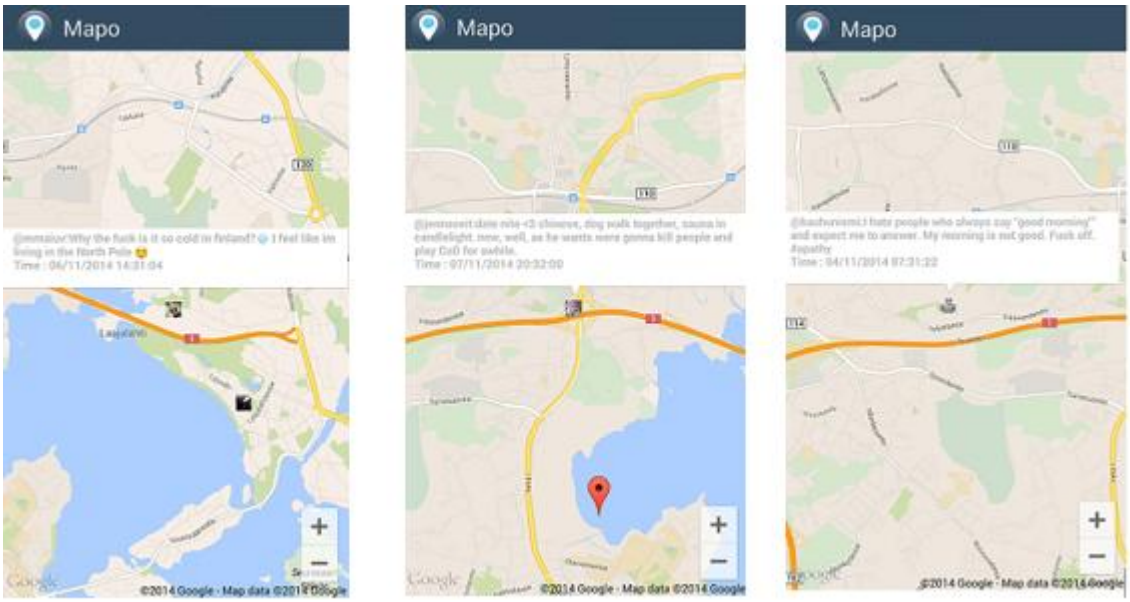

Figure 17 result for keywords, Cold, Date and Morning (Source Author)

6.1.2 Interview 2

Interviewee: Anna Marja from Finland, an electrical engineering student at Aalto University.

When would you use Mapo?

She replied that “I would user it for finding events in my surroundings. I may also use it for fun and finding shopping malls”.

Why would you use Mapo?

She replied that “It seems an interesting idea to find what people around you think and say. I would use it to find what my neighbors have to say”. She seemed really excited about Mapo and asked me, “Are you going to publish this application? When are you going to publish it?” Finally, I have installed the application on her mobile phone.

6.1.3 Interview 3

Interviewee: Waqas Ali from Pakistan, an electrical engineering student at Aalto University.

He has used the application for a while and just couldn't figure out where to use it. However, he added that "he may use Google to find the café or restaurants in an area". After this interview, I have added a new question to my list of questions i.e. why would people use this application if they can use Google to find the café and restaurants?

6.1.4 Interview 4

Interviewee: Teemu from Finland, Aalto University graduate and trainee pilot.

When would you use Mapo?

He replied that "I may use it to find what people are saying around me. If I go to Helsinki, I may use it to find that if someone has tweeted about a good street artist as they usually do not advertise". He further added that "this application can be used to direct people to the place they want to go, for example, in Pori Jazz festival it can be used to direct people to different stalls".

Why would you use Mapo?

He replied that, "I may use the search option for decision making, for example, when I am looking for something specific i.e. restaurants or cafe, a lot of people tweet about them. I may use it for entertainment options i.e. for searching clubs and bars. I think those are the first one to come in my mind. I may use it for searching places and events".

How do you think it can help in decision making?

He added that, "Nowadays many people tweet when visiting a café or restaurant, if a lot of people have tweeted about a restaurant then I would go there".

How do you think this application is different from Google?

He replied that, "I do not know if you can find real time user comments from Google that easy. Comments of users mean a lot, especially when you think of movies. The professional people who evaluate them and put them on Newspapers. I do not agree with them that much. For example, there used to be guys who evaluated movies for Helsingin Sanomat, most of the time movies they say sucked, I liked. I think most of the time users are honest when giving review or opinion". Teemu seemed excited when he used Mapo and added that, "He had discussed a similar idea with one of his friends".

6.1.5 Interview 5

Interviewee: A group of students at Aalto University.

During the interviews session, when I introduced Mapo to a group of students living in Otaniemi Campus they said, “They probably won’t use it in the campus area as they almost know all the events beforehand or can find out about any event from their friends and social network”. However, they were pretty much convinced that, “they would like to use it when they would travel a new country”. They kept playing with Mapo for a while and concluded that,”They would even like to use this application when they visit a place as far as 8 km from Otaniemi, for example, they would use it when they go to Helsinki”. They also added that, “It is different from Google as it shows results on the basis of real time LBSND, which is not available in case of Google”.

From interviews, I came to the conclusion that Mapo can serve as a local community awareness application. It can help users to find a number of things i.e. group of people who share the same interests, opinion of other people about an item, finding events and to know what people around them think and say, events which are not usually advertised such as street artists, finding restaurants and shopping malls. However, during interviews I have noticed that preferences had changed from user to user i.e. food lovers were more interested in food, shopping goers were more into shopping malls while, the others were interested in events. During interview session people seemed interested to look for entertainment, clubs, movies and dating.

6.2 Experiments

The experiment presented here was performed using Mapo in two different locations i.e. Peshawar, Pakistan and London, United Kingdom. I have collected two thousand tweets from each location. The experiment consists of two sub experiments. The first experiment was performed in April 2014, while the second experiment was performed in November 2014. During this experiment tweets were searched without any keywords as I was more interested in all kind of tweets to get a general idea of what people have to share.

6.2.1 First Experiment

I used Mapo to collect two thousand tweets from different areas of Peshawar in April 2014, to find the hot topics of discussion. After analyzing the tweets it was easy to figure out that the politics was the hot topic of discussion in Peshawar. Figure 18 shows sample tweets from Peshawar. Out of five tweets, three were discussing politics. It can be guessed that people of are Peshawar are interested in Politics. Coming from the same city, I can witness the fact that politics is the hottest topic of that area and people usually discuss politics more than any other thing. One of the tweet says, "I'm at Maqbool Peshawari Dairy Icecream in Peshawar" which suggest that people share their location when visiting some café, restaurant or ice-cream polar. While, another tweet says, "With freedom, books, flowers and the moon, who could not be happy".

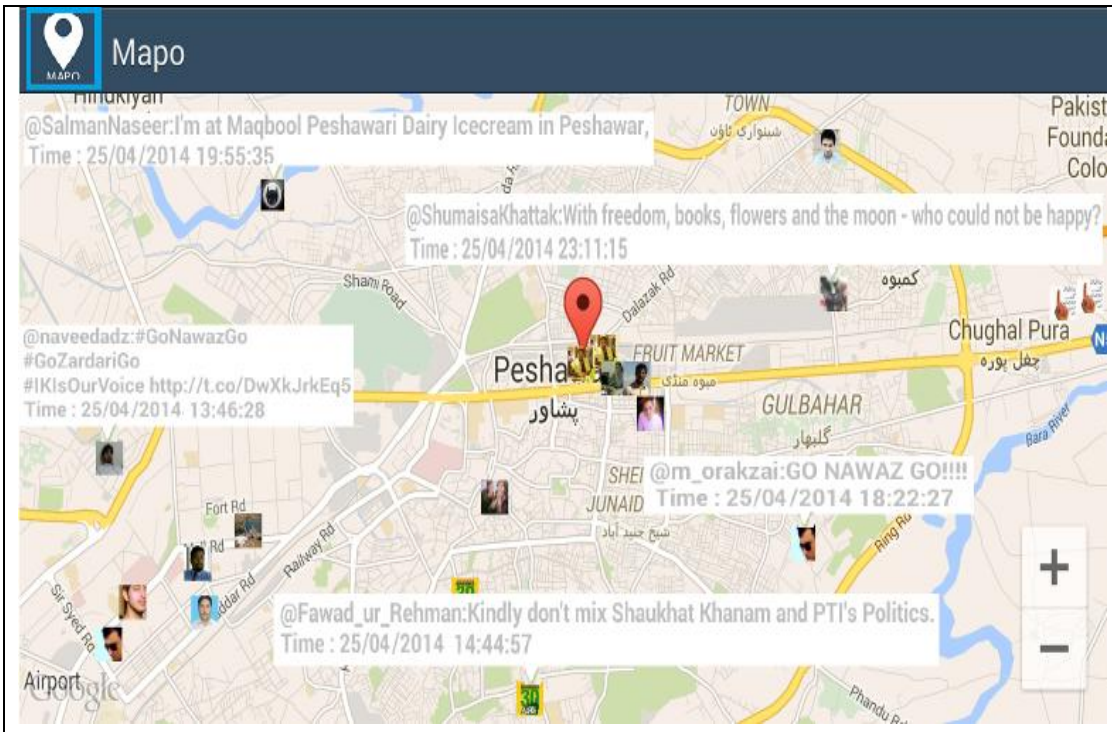

Figure 18: Tweets from Army stadium Peshawar (Source Author)

During the same month of April 2014, I have gathered two thousand tweets from different area of London to find out, what Londoners have to say, Figure 19 shows a sample of the tweets collected from the area of London.

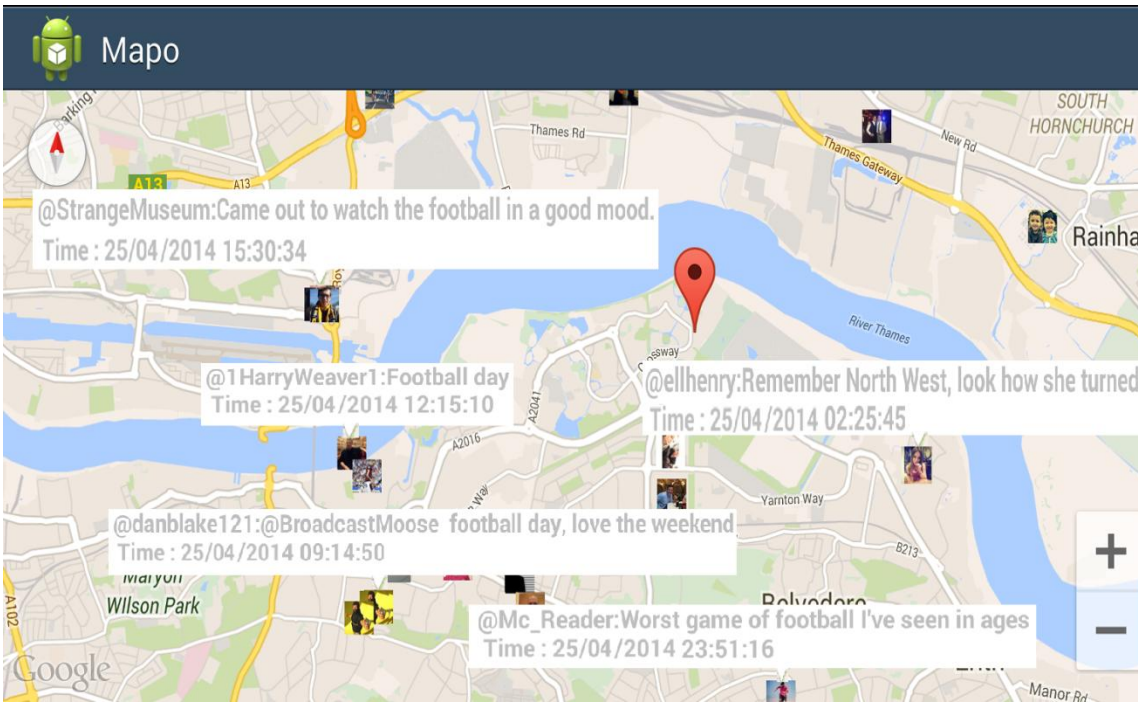

Figure 19: Tweets from London (Source Author)

By looking at the tweets, it was not hard to figure out that football was the famous sports and people were mostly discussing football in their tweets. Compared with Peshawar where people were interested in politics, Londoners seemed more interested in football.

6.2.2 Second Experiment

The second experiment was performed in Nov 2014, seven months after the first experiment to find out what was the hot topic of discussion in Peshawar and London. This time three thousand tweets were collected from different areas of Peshawar to find the hot topics of discussion. Figure 20, shows sample tweets from Peshawar. Out of nine tweets, four were discussing politics, three were discussing the birthday of a national poet, while two other tweets were random. It was quick to figure out that politics was still a hot topic of discussion among Peshawaris. However, it was good to find that if there is some special day then the topic of tweets can change, as in this case people were discussing the birthday of a national poet. After finding out that politics was still a famous topic in Peshawar, I was much interested in finding what people were thinking in London. I collected three thousand tweets from different areas of London and found, football was still famous among Londoners but this time there were tweets about Christmas too. Figure 21, shows a sample of the tweets that were collected from London. Out of 7 tweets two were discussing football while, other two were about Christmas.

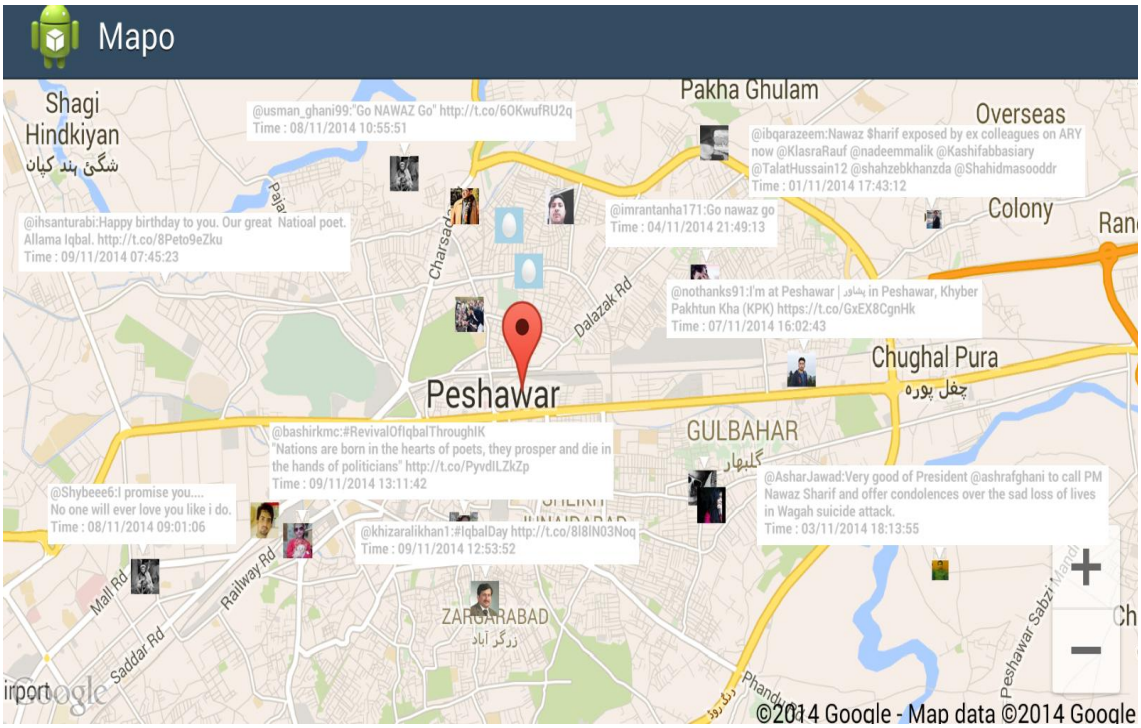

Figure 20: Tweets from Peshawar (Source Author)

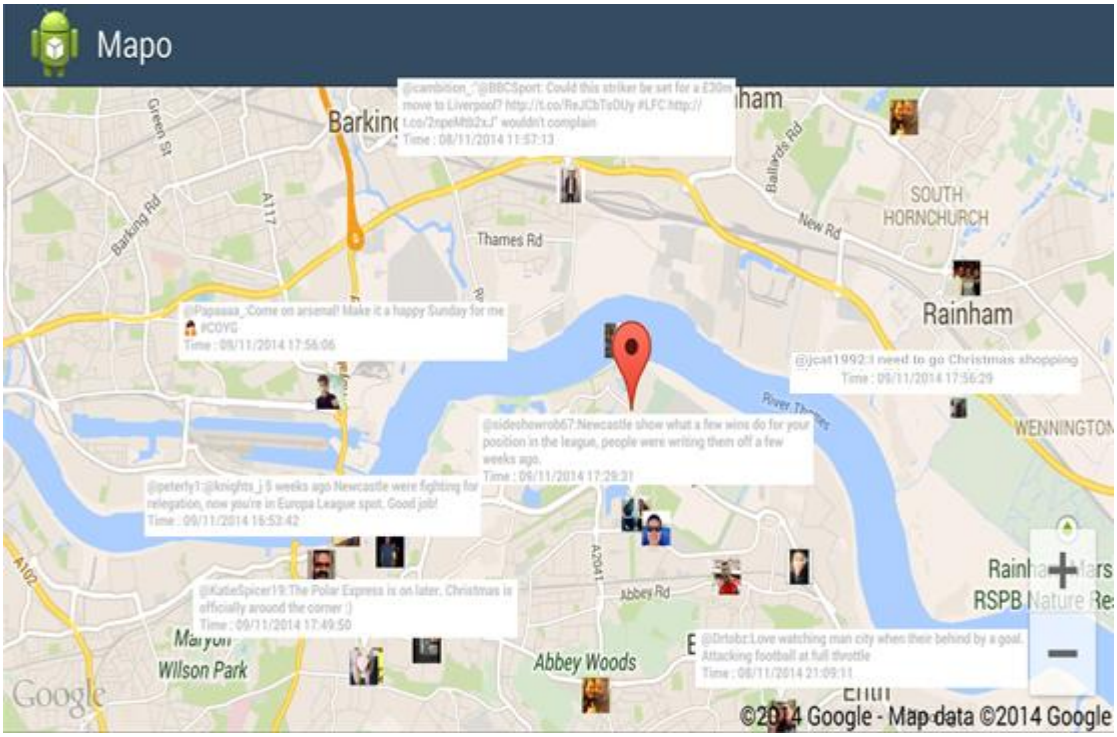

Figure 21: Tweets from London (Source Author)

6.2.3 Conclusion of Experiments 1 and 2

The purpose of these two experiments was to see if Mapo can serve as a *local community awareness application* and can help users to find hot topics of discussion in an area. After the first experiment it was obvious that politics and football were hot topics of discussion in Peshawar and London respectively. After the second experiment which was performed after 7 months, it was found that politics and football were still famous among people of Peshawar and London. However, people in Peshawar and London this time also tweeted about the birthday of a national poet and Christmas respectively, which was an evidence that Mapo can help to find hot and current topics of discussion in an area.

6.2.4 Third Experiment based on Keyword Search

Next, I tried to search tweets by keywords from different areas of London and New York. I started with London and my plan was to find out if there are any restaurants in the area that serve Indian food. Therefore, I selected few keywords such as Kebab, Desi food, India and Indian food. My first keyword was *Kebab* and my intention was to find out if there was a place nearby that serves kebabs. After a quick search, I found that at least there were two places, i.e. Café Fiori and Magic Flame Kebab Shop nearby, see Figure 22. The tweets in Figure 23, show the personal opinions of the users about kebab.

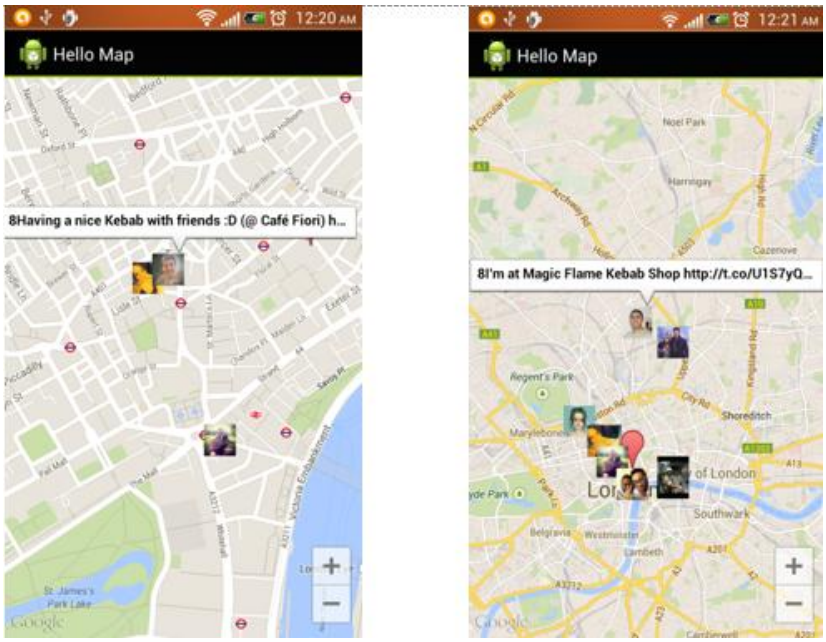

Figure 22: Tweets with name of Kebab places nearby (Source Author)

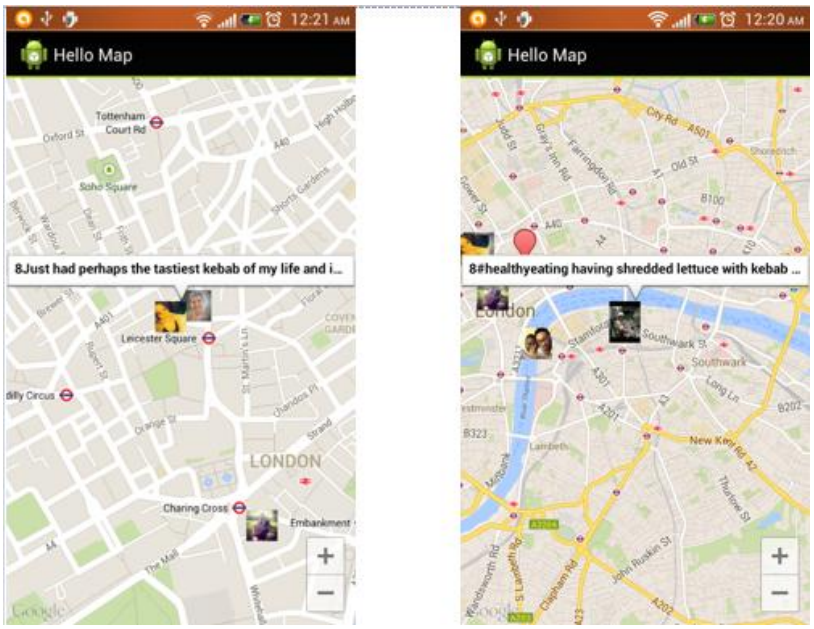

Figure 23: General opinion of people about Kebabs (Source Author)

Next, I tried the keyword *Desi food*, a very common word referring to sub-continental food such as Pakistani and Indian food. I was surprised to find that no tweet were found for these keywords. Therefore, I have tried with keyword *Indian* and got a number of results. In Figure 24, out of three tweets, two were discussing Indian food. They users also mentioned the name of restaurants in the tweet such as Diwana Bhel Pori House and Imli Street.

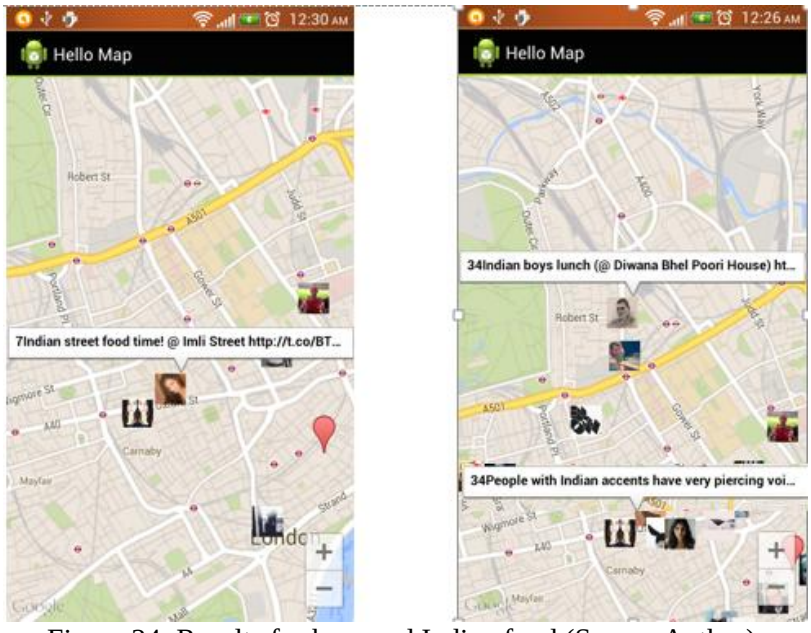

Figure 24: Results for keyword Indian food (Source Author)

While, one tweet was subjective and the user was expressing his opinion about the Indian accent. Figure 25 shows the results for keyword *Indian food*. The tweets about Indian

food are more subjective, one tweet saying “Best Indian food ever @masalazone”, while another tweet said, “Indian food for dinner” without explaining much. However, the tweets displayed in Figure 26 express personal opinions of users about Indian food.

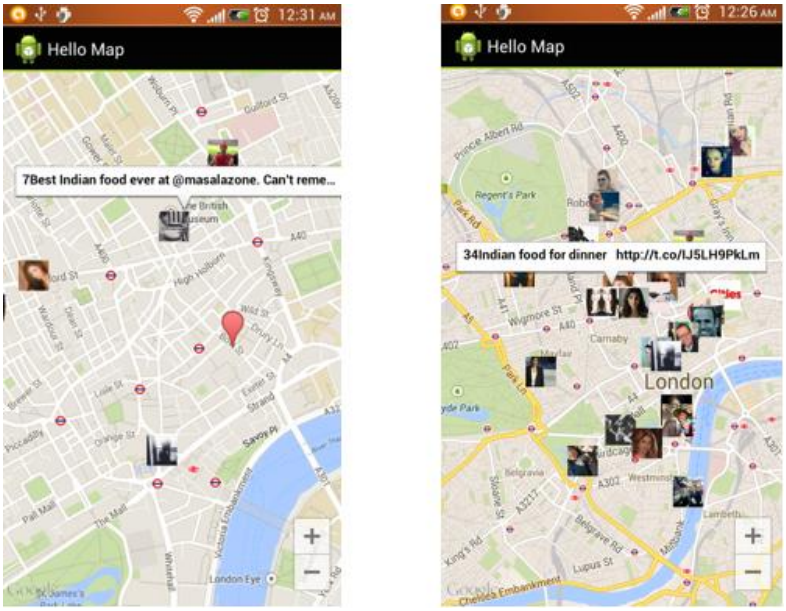

Figure 25: Results for keyword Indian food (Source Author).

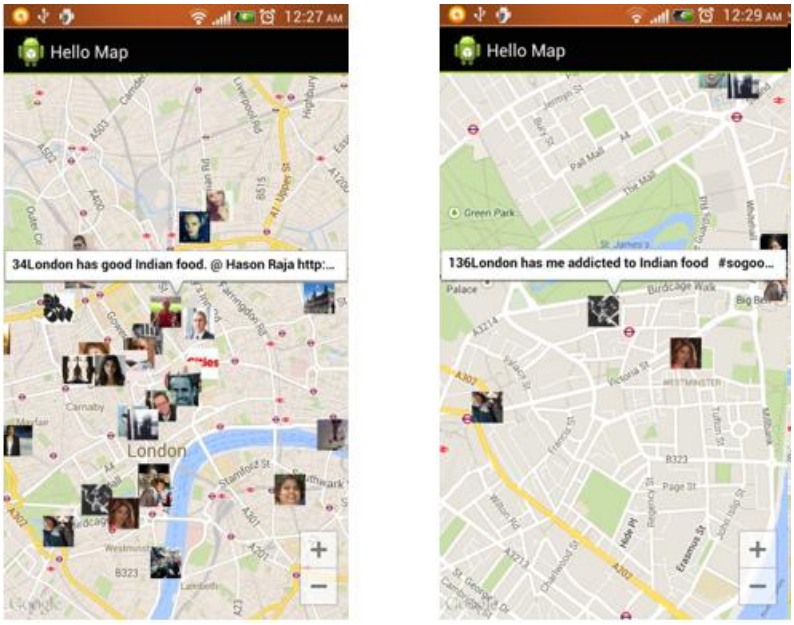

Figure 26::Results for keyword Indian food (Source Author)

My next location was Time Square, New York. I was much eager to know what result I would get for the same keywords which I had searched in London. I didn’t get any tweet for keyword *Kebab* within a radius of two and four mile. However, when I increased the search area to 5 mile radius, I got only one subjective tweet for Kebab, i.e. “Thankful for the shish kebab spot on Broadway”, see Figure 27.

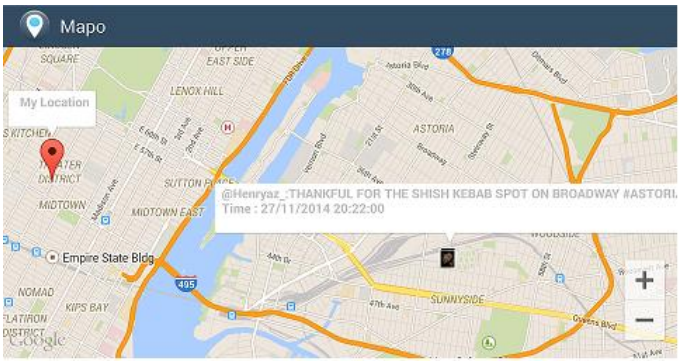

Figure 27: A subjective tweet for Kebab (Source Author)

Similar to the *Kebab*, I have got one Subjective tweet for keyword *Desi food*, i.e. "Lolz. Just remembered that I buried our smoke alarm under my mattress cuz it went off the other day while Smokey Desi food was being cooked", see Figure 28. Lolz at the start of the tweet shows the element of humor in the tweet.

Figure 28: A subjective tweet for Desi food (Source Author)

For keyword *Indian food*, I got a number of tweets which were either subjective or objective but compared with London only one tweet had mentioned Indian restaurant nearby, see Figure 29.

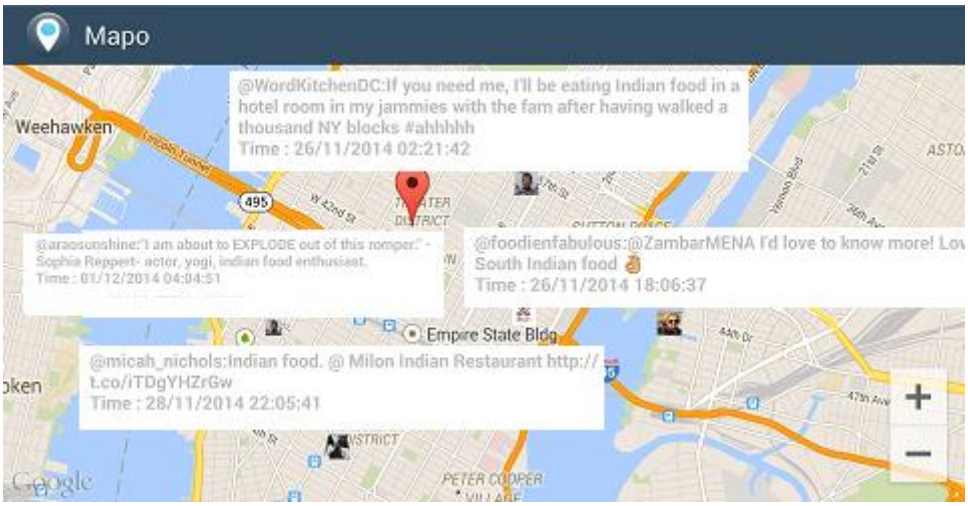

Figure 29: Results for keyword Indian food (Source Author)

My Last keyword was India, after a quick search I got many tweets for the keyword *India.* two users mentioned Indian restaurants in their tweet, i.e. Darbar grill and Vatan Indian vegetarian restaurant see Figure 30. Mapo managed to find three Indian restaurants in the area of Time Square, New York.

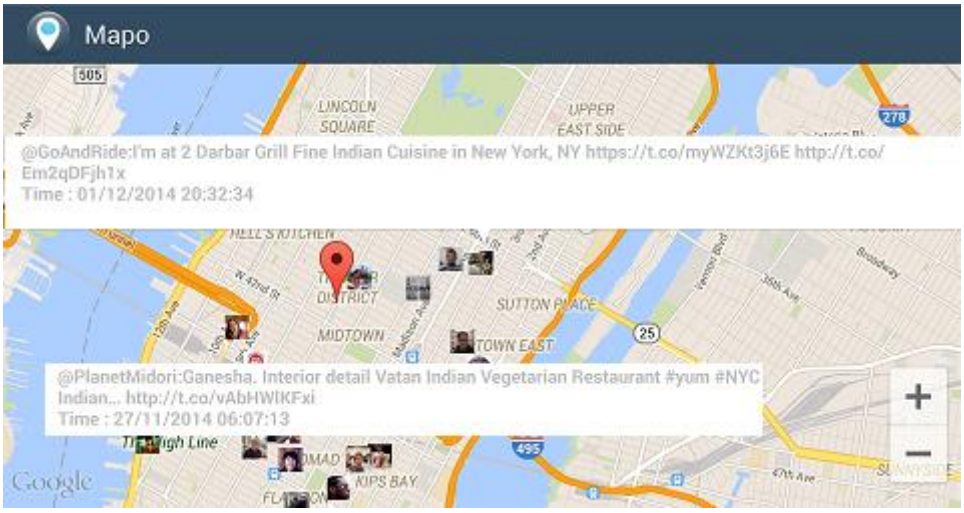

Figure 30: Results for keyword Indian (Source Author)

6.2.5 Conclusion of Experiment 3

The purpose of third experiment was to see if Mapo's keyword search can help users to find different items on the basis of keywords. It helped to find kebab places and Indian food places from London. Keyword search also helped to find users opinions about kebabs and Indian food. Mapo also managed to find Indian food places in the area of

Time Square New York based on tweets. It also helped to find some random tweets which were discussing Indian food. No tweets were found for the keyword *Desi food* and, unlike London no kebab places were found in New York. From experiment 3, it can be concluded that Mapo's keyword search can help users to find an item of their choice. However, a user should use popular keywords when searching for an item.

6.3 Summary

In this chapter, I presented interviews and experiments. Interviews were conducted to find out when and why people would use Mapo. Experiment were performed to see if Mapo fulfills its objectives. By the experiments I have found that Mapo can serve a local community aware application. It can help users to find hot topics of discussion in an area. The keyword search can help users to find different items.

7 Conclusion and Future Work

Mapo is implemented and tested thoroughly, all of its feature works accordingly and produce the required results. The interviews and experiments has proved that, it has potential to serve as a local community awareness application that can help users to find what people around them think and say. It can help a user to find hot topics in an area. The keyword search can help users to find Items of their interests.

I am already in discussion with couple of companies who are interested in the idea to launch it on a bigger scale. In future, navigation and geocoding features would be added to the application. The navigation would help users to navigate to the required place. While, geocoding would help users to find things anywhere in the world from their current location. A language translation feature may be added to translate tweets from different languages into English

References

Acquire Media, (2014). Facebook Reports Fourth Quarter and Full Year 2013 Results [online] Available at: http://investor.fb.com/releasedetail.cfm?ReleaseID=821954 [Accessed June 6, 2014]

Aggarwal, C. C., (2011). An Introduction to social networking data. *Social Network Data Analytics*, pp. 1-15.

Android Design, (2011). Full Screen. Available at: https://developer.android.com/design/patterns/fullscreen.html [Accessed October 12, 2014]

Bao, J., Zheng, Y. and Mokbel, M. F. (2012). Location-based and Preference-aware Recommendation Using Sparse Geo-Social Networking Data. In *ACM GIS*.

Backstrom, L., Sun, E. and Marlow, C. (2010). Find me if you can: improving geographical prediction with social and spatial proximity. *In Proceedings of the 19th International Conference on World Wide Web*, pp. 61–70.

Bansal, N. and Koudas, N. (2007). Blogscope: spatio-temporal analysis of the blogosphere. In *WWW '07*, pp. 1269–1270.

Barbier, G. and Liu, H., (2011). Data mining in Social Media. *Social Network Data Analytics*, pp. 227-252.

Barbosa, L. and Feng, J. (2010). Robust sentiment detection on Twitter from biased and noisy data. *In Proceedings of the 23rd International Conference on Computational Linguistics: Posters*, pp. 36-44.

Barnes, S. and Scornavacca, E. (2004). Mobile marketing: the role of permission and acceptance. *International Journal of Mobile Communications*, Vol. 2, No. 2, pp 128–139.

Bonneau, J., Anderson, J. and Danezis G. (2009). Prying Data out of a Social Network. *Advances in Social Network Analysis and Mining*, pp. 249-254.

Builder, C. (2009). *Career Expert Provides DOs and DON'Ts for Job Seekers on Social Networking.* Caree Builder.

Carrington, P. J., Scott, J. and Wasserman, S. (2005). Models and Methods in Social Network Analysis. *Cambridge University Press.*

Cairncross, F. (1997). The Death of Distance: How the Communications Revolution Is Changing Our Lives. Harvard Business School Press, Cambridge, MA.

Career Builder, (2009). Forty-five Percent of Employers Use Social Networking Sites to Research Job Candidates. Available at: http://www.careerbuilder.com/share/aboutus/pressreleasesdetail.aspx?id=pr519&sd=8/19/2009&ed=12/31/2009&siteid=cbpr&sc_cmp1=cb_pr519_&cbRecursionCnt=1&cbsid=8412d5b32ef54ce6854a035cf3a59d12-303995843-x3-6

Chen, H., Chung, W., Xu, J. J., Wang, G. and Qin, Y. (2004). Crime data mining: A general framework and some examples. IEEE Computer, Vol. 37, No. 4, pp. 50–56.

Cross, R. and Parker, A. (2004). *The Hidden Power of Social Networks*: Harvard Business School Press, Boston, MA.

Chua, F. and Asur, S. (2013). Automatic Summarization of Events from Social Media. *In proceeding ofInternational Conference on Weblogs and Social Media*.

Consolvo, S., Smith, I. Matthews, T., LaMarca, A., Tabert, J. and Powledge, P., (2005). Location disclosure to social relations: why, when, & what people want to share. *In Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 81–90.

Facebook Policy, (2013). Information we receive and how it is used. Available at: https://www.facebook.com/about/privacy [Accessed June 6, 2014]

Developers, (2014). Android, the world's most popular mobile platform. Available at: http://developer.android.com/about/index.html [Accessed May 6, 2014]

Dia, H. (2001). An object-oriented neural network approach to short-term traffic forecasting. *European Journal of Operational Research* Vol. 131, No. 2, pp. 253–26.

Diffen, (2014). Facebook vs. Twitter. Available at: http://www.diffen.com/difference/Facebook_vs_Twitter [Accessed July 6, 2014]

Graham, B. S. (2008). *Fact Gathering/Interviewing Skills. For Process Improvement Projects.* The Ben Graham Corporation .

Padmapriya, A. and Maheswaran, S. (2012). Opinion Search and Retrieval from WWW. *IOSR Journal of Computer Engineering (IOSRJCE)*, 13-17.

eMarketer Data, (2014). Twitter’s growth problem in 5 charts http://digiday.com/platforms/twitters-growth-problem-5-charts/ [Accessed December 6, 2014]

Edwards, J. (2014). Ugly Data for Apple Shows How Desperately It Needs iPhone 6 To Be a Hit Available at: http://www.businessinsider.com/android-ios-market-share-data-and-apples-iphone-6-2014-8 [Accessed 13 July, 2014]

Fahrenthold, D. A. and Kane, P. R. (2011). Anthony Weiner resigns. Available at: http://www.washingtonpost.com/politics/anthony-weiner-to-resign-thursday/2011/06/16/AGrPONXH_story.html [Accessed October 13, 2014]

Gao, H., Barbier, G. and Goolsby, R. (2011). Harnessing the crowdsourcing power of social media for disaster relief. *IEEE Intelligent Systems*, Vol 26, No. 3, pp. 10–14.

Gao, H. and Liu, H. (2014). Data Analysis on Location-based Social Networks. *Springer Link*, 165-194.

Go, A., Bhayani, R., and Huang. L. (2009). Twitter sentiment classification using distant supervision. *Technical report, Stanford Digital Library Technologies Project.*

Google Searches, (2014). Google Search Statistics. Available at: http://www.internetlivestats.com/google-search-statistics [Accessed October 13, 2014]

Goodchild, M.F. (2007). Citizens as Voluntary Sensors: Spatial Data Infrastructure in the World of Web 2.0. *International Journal of Spatial Data Infrastructures Research*, Vol. 2, pp. 24-32.

Gupta, P. and Bhatnagar, V. (2013). Data Preprocessing for Dynamic Social Network Analysis. *Data Mining in Dynamic Social Networks and Fuzzy Systems*, 15.

Gundecha, P., Barbier, G. and Liu, H. (2011). Exploiting vulnerability to secure user privacy on a social networking site. *In Proceedings of the 17th ACM SIGKDD Conference,* pp. 511–519.

Guskin, E. and HitlinPew, P. (2012). Hurricane Sandy and Twitter. *Research Center's Project for Excellence in Journalism*. Available at: http://www.journalism.org/index_report/hurricane_sandy_and_twitter [Accessed October 13, 2014]

Hakim, R. B. F., Subanar. and Winarko, E. (2011). Ranked Clusterability Model of Dyadic Data in Social Network. *Communications in Computer and Information Science,* Vol. 185, pp. 90-99.

Hansen, D. L., Shneiderman, B.and Smith, M. A. (2009) Analyzing (Social Media) Networks with NodeXL, *In Prodeesing of Fourth International Conference on Communities and Technologies,* Lecture Notes in Computer Science. Springer.

Helderman, R. S. (2013). Memphis congressman: Deleted State of the Union tweets went to daughter. Available at: http://www.washingtonpost.com/blogs/post-politics/wp/2013/02/14/memphis-congressman-deleted-state-of-the-union-tweets-went-to-daughter/ [Accessed October 13, 2014]

Hosein, J., Sim, A.T.H. and Saadatdoost, R. (2012). A Naive Recommendation Model for Large Databases. *International Journal of Information and Education Technology.*

Jason, K. (2011). Facebook Has Acquired Gowalla. Available at: http://techcrunch.com/2011/12/02/report-facebook-has-acquired-gowalla/ [Accessed 13 July, 2014]

Jon, S. (2010). The latest from Gowalla is worth checking out. Available at: http://content.usatoday.com/communities/technologylive/post/2010/12/the-latest-from-gowalla-is-worth-checking-out/1#.VBQ7FxDCt8E [Accessed 13 July, 2014]

Jansen, B. J., Booth, D. L. and Spink, A. (2007). Determining the user intent of web search engine queries. *In Proceedings of the 16th international conference on World Wide Web*, pp. 1149–1150.

Java, A. S., X. Finin, T. and Tseng B. (2007). Why We Twitter: Understanding Microblogging Usage and Communities. In Procedings of the Joint 9th WEBKDD and 1st SNA-KDD Workshop. pp. 56-65.

Kaplan, A. M., and Haenlein, M. (2010). Users of the world, unite! The challenges andopportunities of Social Media. *Business Horizons*, Vol. 53 pp. 59-68.

Kongthon, A., Haruechaiyasak, C. Pailai, J., and Kongyoung, S., (2012). The role of Twitter during a natural disaster: Case study of 2011 Thai Flood. *In Proceeding of Technology Management for Emerging Technologies.*

Lazer, D., Pentland, A., Adamic, L. Aral, S. Barabasi, A. L., Brewer, D. and Van Alstyne, M., (2009), Life in the network: the coming age of computational social science. *Science*, Vol. 323, pp. 721-723.

Levinson, P., (2009). New new media. Allyn and Bacon, Boston, MA

Li, L., and Goodchild, M.F. (2010). The Role of Social Networks in Emergency Management: A Research Agenda. *International Journal of Information Systems for Crisis Response and Management (IJISCRAM),* Vol. 2 No.4, pp. 48-58.

Li, L. and Goodchild, M. F. (2012). The Role of Social Networks in Emergency Management: A Research Agenda. *Managing Crises and Disasters with Emerging Technologies: Advancements*, pp. 245-254.

Lindqvist, J., Cranshaw, J., Wiese, J., Hong, J. and Zimmerman, J. (2011). I'm the mayor of my house: examining why people use foursquare-a social-driven location sharing application. *In Proceedings of the 2011 annual conference on Human factors in computing systems,* pp. 2409–2418.

Liu, B. (2010). Sentiment Analysis and Subjectivity. Invited Chapter for the *Handbook of Natural Language Processing*, Second Edition. Available at: http://www.cs.uic.edu/~liub/FBS/NLP-handbook-sentiment-analysis.pdf [Accessed June 6, 2014]

Luft, A. (2009). Canada woman to fight insurance co. over Facebook Available at: http://seattletimes.com/html/nationworld/2010336991_apcncanadafacebookinsurance.html?syndication=rss [Accessed June 6, 2014]

Massa. P., Campagna, M. (2014). Social Media Geographic Information: recent findings and opportunities for smart spatial planning. *In: TeMA - Journal of Land Use, Mobility and Environment Special Issue Eighth International Conference INPUT Smart City Planning for Energy, Transportation and Sustainability of the Urban System*, Naples, 46.

MAUs, 2014. Number of monthly active Twitter users worldwide from 1st quarter 2010 to 2nd quarter 2014. Available at: http://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users [Accessed October 13, 2014]

McDonald, D. W. and M. S. Ackerman. (2000). Expertise Recommender: A Flexible Recommendation System and Architecture. *In ACM Conference on Computer Supported Cooperative Work.* Philadelphia, PA: ACM Press, pp. 231-240.

Mei, Q., Liu, C., Su, H. and Zhai, C. (2006). A probabilistic approach to spatiotemporal theme pattern mining on weblogs. *In Proceeding of WWW '06*, pp. 533–542.

Milgram, S. (1967). The small world problem. *Psychology Today* 1, 61.

Millennials privacy concern. (2014). Concerns about social media privacy according to Millennials in the United States as of February 2014. [Online] Available at: http://www.statista.com/statistics/305605/millennials-social-media-privacy-settings-concern/ [Accessed June 6, 2014]

Miyabe, M., Miura, A. and Aramaki, E., (2012). Use trend analysis of twitter after the great east Japan earthquake. *In Proceeding of ACM Conference on Computer Supported Cooperative Work Companion.*

Mills, S. (2012). How Twitter is winning the 2012 US election Available at: http://www.theguardian.com/commentisfree/2012/oct/16/twitter-winning-2012-us-election [Accessed October 13, 2014]

Monge, R. R. and Kirste, K. K. (1980). Measuring proximity in human organizations. *Social Psychology Quarterly*. Vol. 43, pp. 110-115.

Mogg, T. (2014). Soccer World Cup Final generates 32.1m tweets, breaks TPM record. Available at: http://www.digitaltrends.com/social-media/soccer-world-cup-final-generates-32-1m-tweets-breaks-tpm-record [Accessed October 13, 2014]

Nardi, B. A., Schiano, D. J., Gumbrecht, M. and Swartz, L. (2004). Why we blog. *Communications of the ACM,* Vol. 47, No. 12, pp. 41–46.

Noulas, A., Scellato, S., Mascolo, C. and Pontil. M. (2011). Exploiting semantic annotations for clustering geographic areas and users in location-based social networks. In Fifth International AAAI Conference on Weblogs and SocialMedia.

Prem, M., and Vikas, S. (2010). Recommender Systems. In *Encyclopedia of Machine Learning*, Claude Sammut and Geoffrey Webb (Eds), Springer.

Pontin, J. (2007). From many tweets, one loud voice on the internet. [Online] Available at: http://www.nytimes.com/2007/04/22/business/yourmoney/22stream.html?pagewanted=all&_r=0 [Accessed June 6, 2014]

Reid, E., Pendleton, C. and Tremaine, D. W. (2010). *Information Gathering and Social Networks: Minimizing Exposure in the Digital Age.* 2010: Bloomberg Finance.

Reid, E., Pendleton, C. and Tremaine, D. W. (2010). Information Gathering and Social Networks: Minimizing Exposure in the Digital Age. [Online] Available at: http://www.dwt.com/files/Publication/621067ae-1fdd-4b5c-84d7-350180f21548/Presentation/PublicationAttachment/75feb0d5-eb05-4838-addf-3609e9896df1/pubs_DWT_Bloomberg_InfoGather.pdf breach [Accessed June 6, 2014]

Russia Today. (2013). The Tweet that rocked Wall Street: $200 billion lost on fake message. Available at: http://rt.com/business/tweet-hackers-wall-street-us-326/ [Accessed May 6, 2014]

Scellato, S., Noulas, A., Lambiotte, R. and Mascolo, C. (2011). Socio-spatial properties of online location-based social networks. In ICWSM '11.

SDK. (2014). Get the Android SDK. Available at: https://developer.android.com/sdk/index.html?hl=i [Accessed June 6, 2014]

Social Media Statistic. 2014. Social media, Social networks statistics. . Available at: http://visual.ly/social-networking-2014-stats-and-new-facts-infographic-social-media [Accessed October 13, 2014]

Steve, T. (2014). Facebook vs. Twitter: Who wins the battle for our social attention? Available at: https://www.linkedin.com/pulse/article/20140203133603-13518874-twitter-vs-facebook-who-s-losing-our-attention [Accessed 17 July, 2014]

Sui, D. and Goodchild, M.F. (2011), The convergence of GIS and social media: challenges for GIScience, *International Journal of Geographical Information Science*, Vol. 25, No. 11, pp. 1737-1748.

Symeonidis, P. et al. (2014) Recommender Systems. *Recommender Systems for Location-based Social Networks*, SpringerBriefs in Electrical and Computer Engineering, DOI 10.1007/978-1-4939-0286-6__2.

Takhteyev, Y., Gruzd, A., and Wellman, B. (2011). Geography of Twitter networks. *Social Networks*, Vol. 34, No. 1, pp. 1-25.

Twitter usage. 2014. Our mission: To give everyone the power to create and share ideas and information instantly, without barriers. Available at: https://about.twitter.com/company [Accessed October 12, 2014]

Foursquare Blog. (2013). Ending the year on a great note (And with a huge thanks and happy holidays to our 45,000,000-strong community. Available at: http://blog.foursquare.com/post/70494343901/ending-the-year-on-a-great-note-and-with-a-huge-thanks [Accessed May 6, 2014]

Twitter Authorization. (2014). Obtaining access tokens Available at: https://dev.twitter.com/oauth/overview [Accessed October 12, 2014]

Twitter's global user. (2014). eMarketer's Twitter's user growth between 2012 – 2018. Available at: https://datawrapper.de/chart/EJKuw/publish [Accessed October 12, 2014]

Twitter Privacy Policy. (2013). Information Collection and Use. [Online] Available at: https://twitter.com/privacy [Accessed June 6, 2014]

Twitter's report. (2014). Twitter Reports Second Quarter 2014 Results. Available at: https://investor.twitterinc.com/releasedetail.cfm?releaseid=862505 [Accessed October 12, 2014]

Tsukayama, H. (2013). European regulators step up pressure on Google over privacy policies. Available at: http://www.washingtonpost.com/business/technology/european-regulators-step-up-pressure-on-google-over-privacy-policies/2013/07/05/27a48a12-e58c-11e2-a11e-c2ea876a8f30_story.html [Accessed November 1, 2014]

Tweet Emotions. (2012). Available at: https://twitter.com/TweetEmoteApp [Accessed June 6, 2014]

Typhoon Haiyan. 2013. The Role of Twitter in Natural Disasters & Typhoon Haiyan Available at: http://wordsalad.com.au/social-media/the-role-of-twitter-in-natural-disasters [Accessed October 13, 2014]

USA Today. (2013). Hoax and ensuing crash on Wall Street show the new dangers of our light-speed media world. Available at: http://www.usatoday.com/story/news/nation/2013/04/23/hack-attack-on-associated-press-shows-vulnerable-media/2106985/ [Accessed May 6, 2014]

Wang, F. and Huang, Q. (2010). The importance of spatial-temporal issues for case-based reasoning in disaster management. *In Proceeding of 18th International Conference on Geoinformatics*, pp. 1–5.

Wellman, B. (1979). The Community Question: The Intimate Networks of East Yorkers. *American Journal of Sociology,* Vol.84, No. 5.

Wasserman, S. and Faust, K. (1994). *Social Network Analysis Methods and Applications.* Cambridge: Cambridge University Press.

Youtube Viewership. 2014. Youtube Statistics. Available at: https://www.youtube.com/yt/press/statistics.html [Accessed October 13, 2014]